EVALUATION OF A TECHNOLOGICAL CHANGE IN PRODUCTION

Robert Lee Spooner

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

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by

Robert Lee Spooner

Thesis Advisor: N.K. Womer

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Evaluation of a Technological Change in Production

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Robert Lee Spooner
Captain, United States Marine Corps
B.S., United States Naval Academy, 1966

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ABSTRACT

The Management System Development Office (MSDO) of the Naval Air Integrated Logistic Support Center (NAILSC) is presently evaluating a prototype system at the Naval Air Rework Facility, North Island (NARFNI). The system is called "work-in-progress inventory control system", (WIPICS). This paper is concerned with that evaluation and shall utilize before WIPICS production data provided by NARFNI for analysis. Three production functions for three different outputs each with three input variables are discussed and inter-relationships are identified and explained. Three Cobb-Douglas production functions constrain the cost minimization problem. Prices of inputs are constant and a minimum budget is derived for various output levels. Finally, a discussion of the possible results and their meanings is offered to improve understanding of the before and after WIPICS analysis.

TABLE OF CONTENTS

LIST OF FIGURES

I. INTRODUCTION

A. ORGANIZATION, MSDO

The purpose of this thesis is to provide tools and concepts for the evaluation of a new system, the Work In Process Inventory Control System (WIPICS). This evaluation is being conducted by the relatively new Management Systems Development Office (MSDO). The organizational alignment of the three year old MSDO is through the Commander, Naval Air Integrated Logistics Support Center (NAILSC), Patuxent River, Maryland to Naval Air Systems Command (NAVAIRSYSCOM), Washington, D.C., (Figure 1). Program management is provided by NAVAIRSYSCOM 105, the Management Information Systems Development Division (MISDD). MSDO is organized and staffed to provide management input as well as computer systems input in the development of an integrated Management System and Management Information System (MS/MIS).

B. ORGANIZATION, NARFNI

The Naval Air Rework Facility, North Island (NARFNI) is one of the largest repair facilities of its kind in the world. It is presently one of seven facilities servicing aircraft of the United States Navy and Marine Corps. It is directly responsible for major maintenance, incorporation of technical changes and repair of "crash damaged" aircraft for West Coast based F-4, F-8 aircraft and H-46, H-53 and H-3 helicopters, as well as engines and components contained

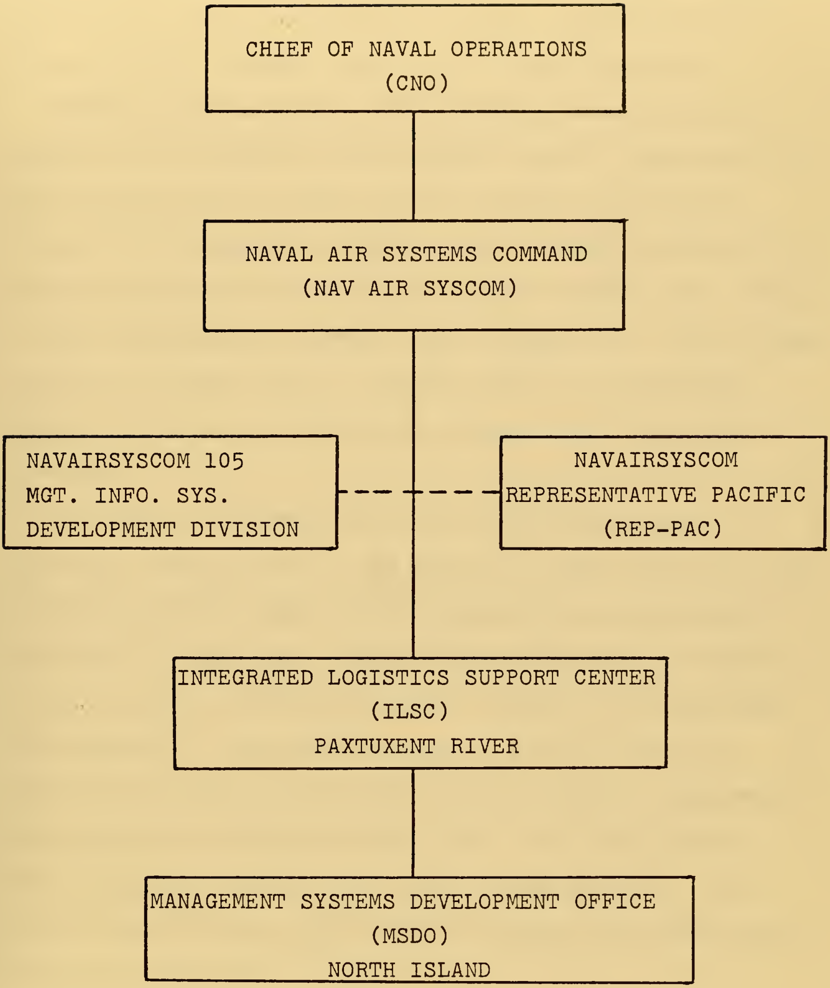


Figure 1. CHAIN OF COMMAND TO MSDO

within those vehicles. The NARF primary objective is to complete the required workload during a specific period of time at the minimum total cost to the government.

NARF is responsible to NAVAIRSYSCOM, Representative, Pacific in carrying out its assigned tasks. Evaluation of fleet requirements is made by the CNO and promulgated through the Commander-in-Chief, Pacific Fleet (CINCPACFLT), from an interpretation of the Five-Year Defense Plan (FYDP) of the Department of Defense (DOD) [Figure 2]. The services provided by NARFNI are an integral part of our national defense in terms of operational aircraft and helicopter strengths.

The large investment that the government has made in the NARFNI can be seen in the physical plant consisting of buildings, hangers test cells, laboratories, and airport facilities. The Plant, encompassing 298 acres, is valued at $115 million, plus $18 million budgeted for rebuilding and expansion. The yearly budget is $150 million and approximately 300 aircraft and 100,000 related components are repaired or overhauled each year. The total labor force employed by NARFNI is nearly 6,800 persons. This force is split about half and half between supervisory and production employees.

Two major problems facing all NARF's are the variable workload and optimal utilization of manpower and material. Each quarter of the fiscal year conferences are held with NARF representatives and CINCPACFLT representatives. NARFNI

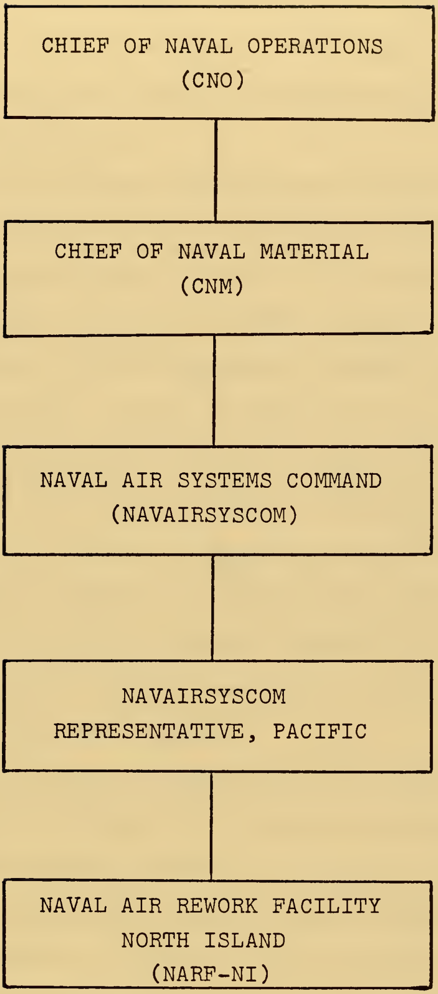


Figure 2. CHAIN OF COMMAND TO NARF-NI.

contracts, at these conferences, to rework a specific number of aircraft and components during the upcoming fiscal quarter and attempts to schedule an even flow of work. Without this scheduling the optimum utilization of resources would be more difficult.

Since all aircraft and engines utilized by the military are highly sophisticated and complex in nature, a planned program for maintenance is the key to continued performance and operational readiness. NARF provides a regular cycle of maintenance called Progressive Aircraft Rework (PAR) for each aircraft. Prior to induction in the NARF, an estimate is made, from historical data, of the man-hours and material required to rework an aircraft in order to bring it up to technical standards set by NAVAIRSYSCOM. A good example would be a four-year-old F-4J, after three cruises to the Western Pacific (WESTPAC), on the average, would require ten thousand man-hours and thirty-two days to complete the work required.

When an aircraft is scheduled for a PAR induction date, the necessary components are ordered and managers must determine the optimal allocation of existing manpower resources necessary to accomplish the workload. Simultaneously, several manpower utilization options must be feasible in case the work load is varied due to combat losses or other unforeseen changes. Aircraft are scheduled to arrive a few days prior to induction in order to be inventoried and inspected. On day zero, it enters the system and should

then take an exact number of days and consume a set number of man-hours to complete the overhaul. With this background in mind, it is easy to see that the efficient allocation of resources and manpower is no easy task. WIPICS is an attempt to make use of today's computer technology to provide NARF managers with accurate, up-to-date information as a basis for their allocation decisions.

C. WIPICS

In early 1969, at the request of MSDO, ROHR Corporation studied the Naval Air Rework Facility, Naval Air Station, North Island, California (NARFNI), to investigate possible adaptation of WIPICS to the NARF. By November, 1969, a request was initiated by MSDO for a contract with ROHR to install a prototype of WIPICS. The Secretary of the Navy approved and authorized the prototype in July of 1970 and the contract negotiation phase began in October, 1970. [Figure 3] The effective date of the ultimate contract was 4 January 1971. Prototype milestones were agreed to with a two year completion date set at 31 December 1972. [Figure 4]

1. Early 1969 - ROHR Corporation studied NARF-NI
2. Late 1969 - MSDO requested contract
3. Early 1970 - NAVAIRSYSCOM evaluation and approval
4. July 1970 - SECNAV authority for prototype
5. Late 1970 - Contract negotiation phase
6. 4 January 1971 - Contract date

FIGURE 3. Historical Background

1. D-Day - Effective date of contract 4 January 1971
2. D + 9.5 months - WIPICS System developed
3. D + 11 months - WIPICS Systems test
4. D + 11.5 months - WIPICS prototype started
5. D + 24 months - WIPICS prototype complete
   31 December 1972

FIGURE 4. WIPICS Milestones

How WIPICS came into existence has been briefly explained and the external organization of the NARF and MSDO has been presented in order to better understand the part that WIPICS plays in the NARF. Now the question can be asked, Why WIPICS? WIPICS exists probably as the result of the farsightedness of one Naval Officer, Rear Admiral Smith, who clearly saw the need for more advanced management systems and then did something about it. WIPICS is an extension of NAILC/MIS Plan of 1969 and is an attempt to improve management decisions made by the officials responsible for the production of aircraft and components at NARFNI. The hoped-for production improvements will come as either a dollar savings or actual production-time savings.

WIPICS is designed to control work in process by utilizing a computer and the computer's associated memory bank. This system is designed to use any on-line computer system with minimum changes. Presently, the Rohr Corporation is using the IBM-360 as the primary unit. Future application

of the system would encompass the other six NARFs and each would have common programs.

The hardware used in addition to the computer encompasses 164 touchtone and 20 alphanumeric terminals strategically placed throughout the repair facility and four teletypewriters for on-line printing of selected data as well as batch processing and printed reports of off-line information. One IBM 7770 audio response unit with a vocabulary of approximately 80 words is used for on-the-spot recall of data for information or verification. This unit is connected to all 184 phone terminals, touchtone and alphanumeric located throughout the shop. A data card reader is also available for use in batch processing of daily, weekly or quarterly information. The system in this form is capable of handling 30,000 transactions per day. Another IBM 360 is used as a back-up unit and either unit has a file dump to tape for use every 24 hours.

Inputs to this system can be made by touchtone from the plant floor, by data card through a card reader, from the data bank, by audio response unit, from the teletypewriter terminal or from a tape source. [Figure 5]

There exist two outlets for system information recovery. First is the audio-response program which answers inquiries over one of the 186 terminals. Secondly, the teletypewriter will print information as requested either on-line to simple inquiries or off-line to more complex needs. [Figure 6] These two outlets will provide item location,

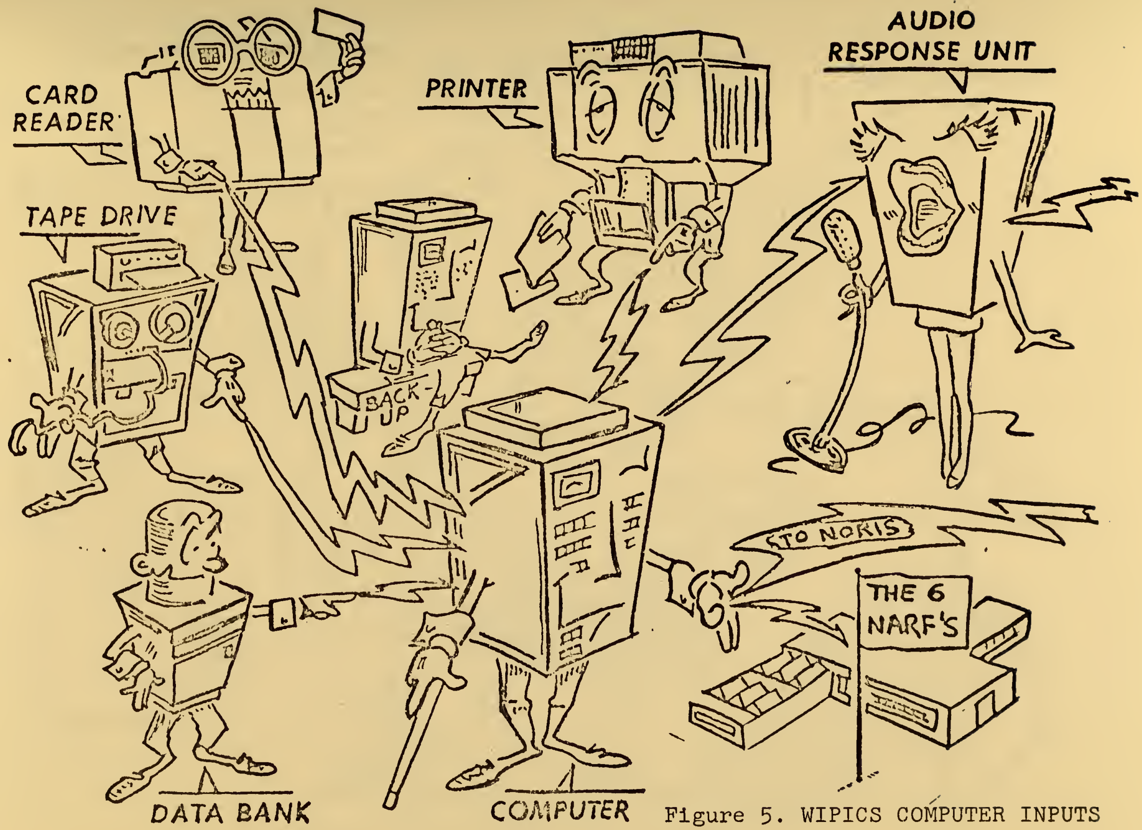


Figure 5. WIPICS COMPUTER INPUTS

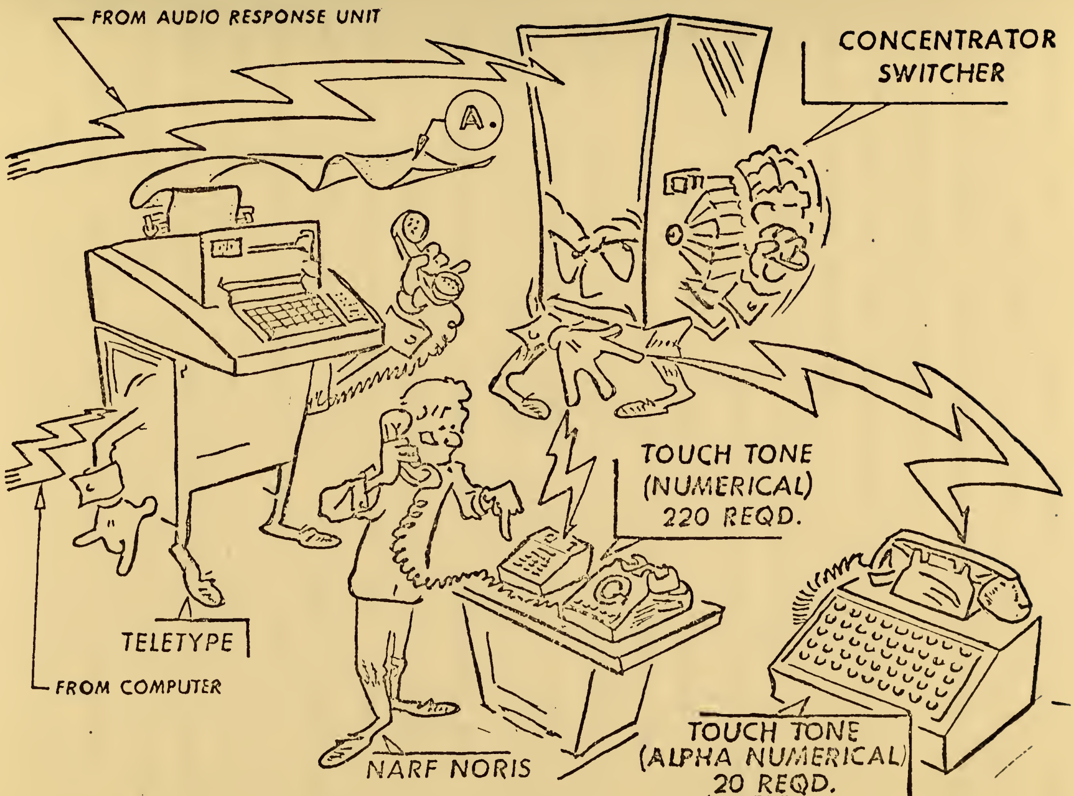


Figure 6. WIPICS SYSTEM INPUT/OUTPUT

its present and projected status and the relationship to all other items. Items in this case referring to individual engines or aircraft and any sub-assembly portions of either required for completion of production. Questions such as listed in Figure 7 can be answered at any time with clarity and without difficult interpolation.

How does the WIPICS system work in an operational sense? For each work-in-process item a location control record is established when the item first enters the system. This entry may be as the aircraft item rolls in the hanger or as the engine item is dismantled from an aircraft. The record contains such things as the control number, part number, register number, location data, and schedule data. As the item progresses through the maintenance schedule the computer is kept posted by each shop or work center as it arrives and as the work is completed. A necessary link to this system is the pre-programmed operations listing. Each operation to be performed is identified in terms of work to be done, material required and skilled labor needed for completion of the operation. When the scheduler in the assembly shop, for instance, is planning the next day's work he can touchtone a query [Figure 8]. The results can be received by audio response or printed readout, whichever is required. This real time information is invaluable, when trying to optimize utilization of men, material and money.

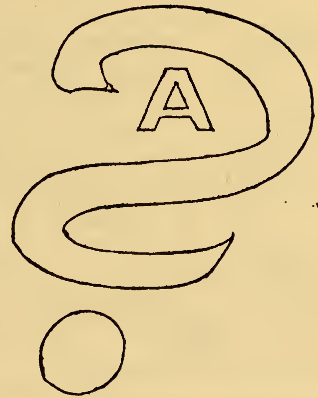
WHERE IS IT ?

HOW LONG HAS IT BEEN THERE ?

WHEN IS IT DUE ?

WHY IS IT ON "HOLD" ?

WHAT IS ITS PRIORITY ?



WHAT PARTS ARE MISSING FOR THIS PARTICULAR

AIRCRAFT, WHAT IS THEIR SCHEDULE? WHERE ARE THEY ?

WHAT ORDERS DO WE HAVE IN WORK

FOR THIS PART NO. ?

Figure 7. QUESTIONS ANSWERED BY WIPICS

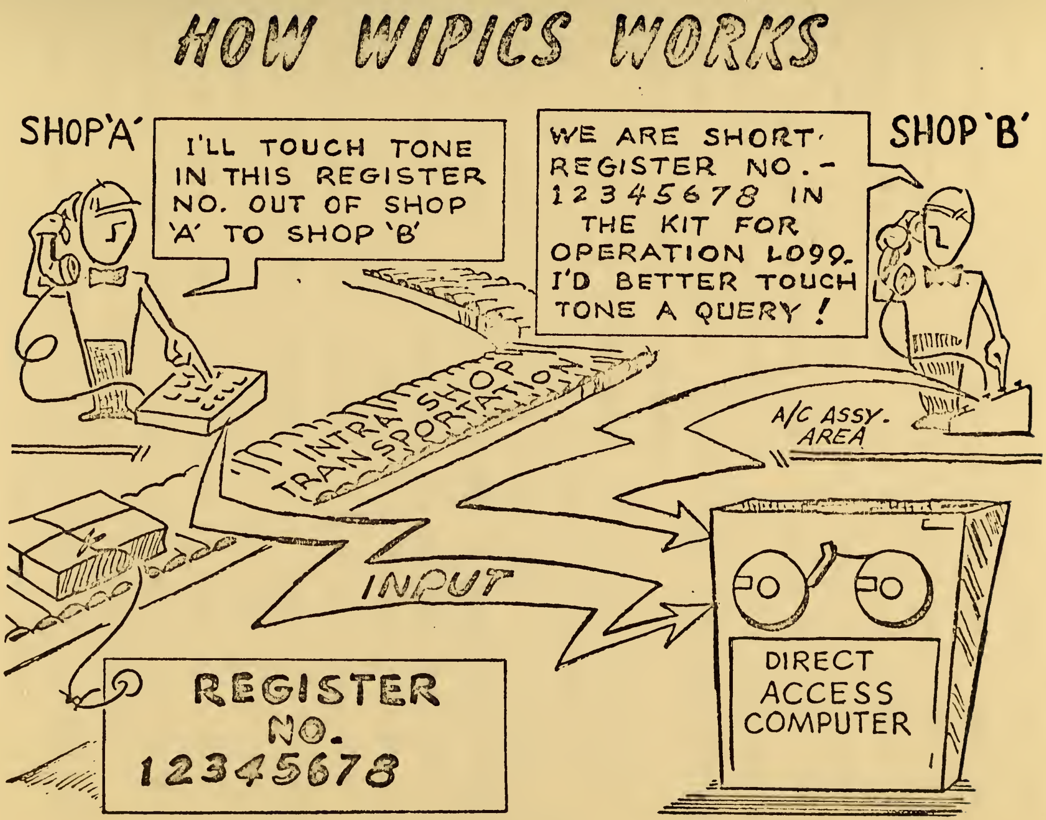


Figure 8. HOW WIPICS WORKS

The production control staff is provided with real time data regarding condition, status and location of all work-in-process. For this work-in-process a listing can be obtained based on the part identification input or register number irrespective of the rework program under which the items are being processed. Data can also be retrieved by a family code. In order to avoid multiplicative errors, all input data is checked against previous files for correctness and a daily printout is made of all lost items and/or illogical inputs. Occasionally, auxiliary files and tables may be used for reference.

A transaction backup record is maintained and can be used for recall as needed. The use of this backup in quality assurance work alone is important. For example, if an aircraft, engine or component is inspected and found to be defective in a particular sub-assembly the backup record will list all effected products or unused assemblies. In addition, if this defect was caused by a human error the responsible shop personnel may be listed and retrained. The potential is there to expand WIPICS into other areas of the plant. Input of attendance and labor data could eliminate time clocks and make less work for disbursing clerks. Technical changes could be incorporated and continuously monitored and the all-automated storage areas would be easy to integrate with this new system.

II. THE PROBLEM

In recent years, Department of Defense policy has placed increasing emphasis on economy in the expenditure of its resources. The need for new equipment and new technology must be reviewed and analyzed. Consequently, the Navy is tasked with proving the need for new technology and for documenting its development from initial contract to final acceptance. The management of this development is critical and requires both qualitative and quantitative analysis.

The subject of OPNAV instruction 5231.1 is Automated Data System (ADS), Development and is concerned with the procedures for the management of these developments. An enclosure to this instruction is the ADS development plan; whose purpose is to provide a comprehensive, detailed justification of ADS development, conversion or major revision proposals. The plan is designed to answer these fundamental questions: (1) Where are we? (2) Where do we want to be? (3) What specific steps are we going to take? (4) Who is responsible? (5) What resources are required? (6) Is the trip worthwhile?[1] These questions are addressed in the economic analysis part of each new development plan. The problem addressed in this paper is how does one prove that the trip was in fact worthwhile?

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[1]Naval Operations, Chief of, OPNAV Instruction 5231.1, Subject: Automated Data Systems Development, Encl: (2), p. 1, 30 May 1972.

A. ECONOMIC ANALYSIS REQUIREMENTS

The economic analysis part of the development plan must present analytical justification of the proposed ADS development, conversion or major revision. WIPICS, since conception, has had such a plan and all milestone requirements have been met as WIPICS progressed to completion. The development plan requires a description of the before WIPICS system and statement about its objectives. The new system, WIPICS, is to be compared in terms of what assistance it provides toward satisfying the stated objectives of the old system.

The format for the economic analysis is carefully outlined into sections to give uniformity to different areas of analysis and to make the next higher command review easier. The first section is a brief synopsis. Secondly, the problem must be stated or, in this case, the opportunity for improvement must be described. This statement must be written in such a manner that continuous review is facilitated. The following is a list of sections in order, each is self-explanatory and must deal with the problem as stated in section 2. Section 1 - Synopsis, Section 2 - Problem Statement, Section 3 - Environment Description, Section 4 - Objectives, Section 5 - Assumptions and Constraints, Section 6 - Alternatives, Section 7 - Costs, Section 8 - Benefits, Section 9 - Comparison of Alternatives,

Section 10 - Sensitivity Test, Section 11 - Milestone Progress Report.[2]

The major objective of WIPICS, as stated in the Rohr proposal is to provide a tool for the NARFNI production control staff which will assist them in achieving reduced repair and overhaul cycles through improved parts location and status control. This objective clearly relates to the before WIPICS system and calls for a specific improvement. Inherent in the objectives of the original proposal was a subsequent reduction in labor cost and material dollar expenditures. In order to gain SECNAV approval, this plan had to estimate cost savings and system benefits which exceeded the existing systems potential for improvement. The improvement was predicted to be of sufficient value to offset the cost of the contract with Rohr Corporation.

B. COST SAVINGS AND SYSTEMS BENEFITS

This paper will be primarily concerned with the economic analysis of WIPICS in two of the eleven sections previously mentioned, cost savings and system benefits. The primary objective is to formulate a method of evaluating the new system improvements and performances versus the old systems performance.

In order to formulate a method of evaluation the entire NARF program came under scrutiny in an attempt to eliminate unimportant inputs as well as to better understand the

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[2] _Ibid._, pp. 3-12.

forecasted improvements documented in the initial analysis. To evaluate the success or failure of the new system a baseline had to be established from the data available. The data cover a period of nearly two years prior to the introduction of WIPICS and documents such items as repairs completed, labor costs, material costs, indirect labor costs and overhead expenses. It must be demonstrated that WIPICS either increased or decreased production output with the same budget. This paper will provide a method by which the success or failure of WIPICS can be documented.

III. GENERAL APPROACH TO THE PROGRAM

This section examines concepts that may be used to help identify and verify benefits derived from the implementation of a technological change in a production program. Understanding the useage and value of production functions, cost functions and certain mathematical techniques can make easier the evaluation of new systems.

A. PRODUCTION FUNCTIONS

The production of an output by using several inputs or resources can be modeled as a production function of the form,

$$(3\text{-}1) \quad Q = F(X_1, X_2, \ldots, X_n)$$

where Q is (homogeneous) output and X_i's are variable inputs to the function. The validity of a particular production function is determined by how closely the relationship between inputs and output approximates reality. Fo find the production function that best describes the relationship of a firm's output to their input requires an understanding of the firms objectives, operations, and actual input and output data.

The production function may be depicted by a table, a graph, or an equation which shows the maximum rate of output subject to a specified set of inputs. A table such as Table 3.1 is a form of production function Q = F(x)

OUTPUT (units)	LABOR (# men)
16	1
33	2
50	3
60	4
70	5
75	6

Table 3.1 OUTPUT VERSUS LABOR INPUT

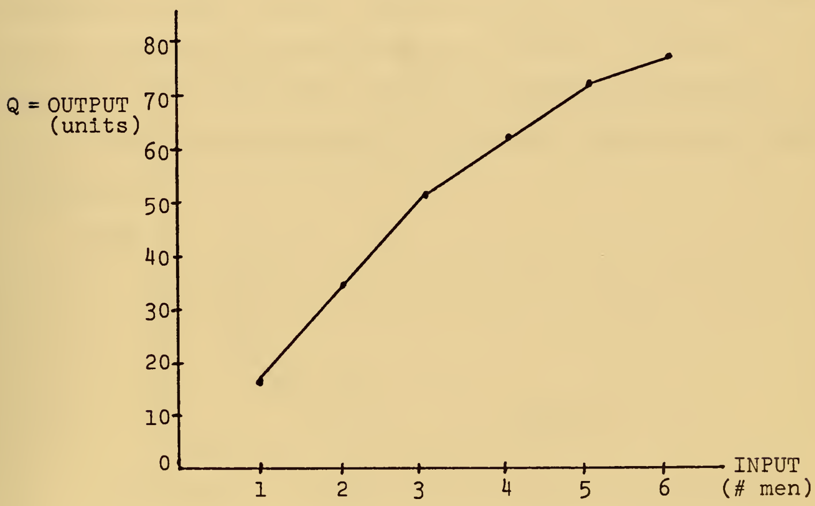

Figure 9. OUTPUT VERSUS SINGLE VARIABLE INPUT

indicating output achieved from a single input. This information could be represented on a graph, as in Figure 9.

From the table 3.1 and the graph in Figure 9, an equation could be derived that would represent the production function. This is a simple case since the function is dependent on only one variable.

A more interesting but more complicated case is where the production function is dependent on two variables. In order to extract information from a two input table or draw a graphical representation it is common to hold one variable constant or look at the combinations of variables that produce the same output. Figure 10 shows equal production points for different combinations of inputs. The two variable cases can give a series of constant production points which when smoothed and connected together are called isoquants.

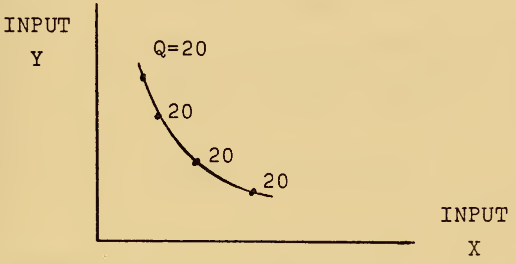

FIGURE 10. Constant Output From Two Variables

"An isoquant shows the various combinations of two inputs that result in an equal output for the firm."[3] Given the production function, one can derive an isoquant pertaining to any level of output. The isoquant will be a representation of only efficient combinations of inputs. For example, if 2 units of output can be produced by 2 units of X_2 and 3 units of X_1 as well as by 2 units of X_2 and 4 units of X_1, the latter will be ignored because it is obviously inefficient.

Production equations may be additive, multiplicative or any mathematical combination that represents the production of any output. The equations that follow are common examples of just such representations.

Q represents output, X_1 and X_2 inputs and a,b,α,β are all constant parameters.

(1) LINEAR RELATIONSHIP

$$Q = ax_1 + bx_2 \tag{3-2}$$

(2) NON-LINEAR RELATIONSHIP

$$Q = ax_1 + bx_2^2 \tag{3-3}$$

$$Q = ax_1^{\alpha} x_2^{\beta} \tag{3-4}$$

Equation (3-4) is known as the Cobb-Douglas Function. This function is dependent on the values for α and β. The relationship between an input variable and output is linear

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[3]Mansfield, Edwin, <u>Microeconomics</u>, New York: W. Norton Co., p. 133, 1970.

if the α and β power is equal to 1 when the other input is fixed. If not equal to 1, the relationship is non-linear. The parameters α and β represent the percentage increase of a unit of output when one unit of related input is added and all other variables remain the same. The significance of α and β when their sum is less than 1 is that the law of diminishing returns applies to the output results. The law has been documented in the "real world" many times over and simply states that, at a certain point, as equal increments of an input are added, the output results do not increase proportionally. This law assumes all other variables are held constant! Increasing returns require that $\alpha+\beta$ be greater than 1.

B. COST FUNCTIONS

Efficient production is that which utilizes the least input to produce the desired output. The least input will require the smallest outlay of constant dollars. In the case of multiple inputs the decision as to what mix to use for production is a function of the cost of those individual inputs. "To minimize the cost of producing a given output, a firm must combine inputs so that the marginal product of a dollar's worth of any one input is equal to the marginal product of a dollar's worth of any other input."[4] In the case where the price of inputs are constant the most

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[4] Ibid., p. 184.

efficient point of production can be found where the cost line is tangent to the isoquant at the output desired.

$$\text{(3-5)} \quad \text{Cost} = C = 2X_1 + X_2$$

Equation (3-5) is a cost equation in which the price of x input is twice that of y input. Figure 11 illustrates how this cost function is to be used to find the optimum mix of inputs. The production output isoquant (A) and the cost curve (C) are tangent at point (B) and indicates the optimum mix of X_1 and X_2.

C. LAGRANGE MULTIPLIER TECHNIQUE

"This method (the method of Lagrange Multipliers) can be used to find the maximum or minimum value of a non-linear objective function that is constrained by one or more equality constraints."[5]

The minimization of a cost function subject to production function constraints can be solved by the Lagrange technique. For problems with four constraints or fewer, this technique is computationally acceptable. When more constraints are present, other methods such as sequential unconstrained minimization or geometric programming techniques may be used.[6]

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[5]Plane, Donald R. and Kochenberger, Gary A., Operations Research for Managerial Decisions, Homewood, Illinois: R. D. Irwin, Inc., p. 282, 1972

[6]Ibid., pp. 284-291.

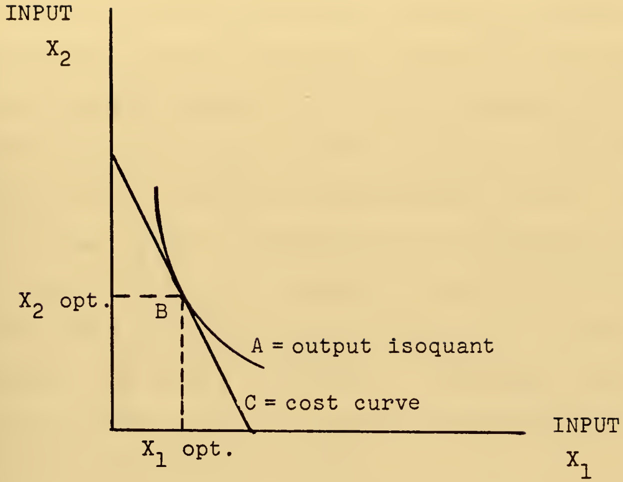


Figure 11. PRODUCTION MIX AND MINIMUM COST

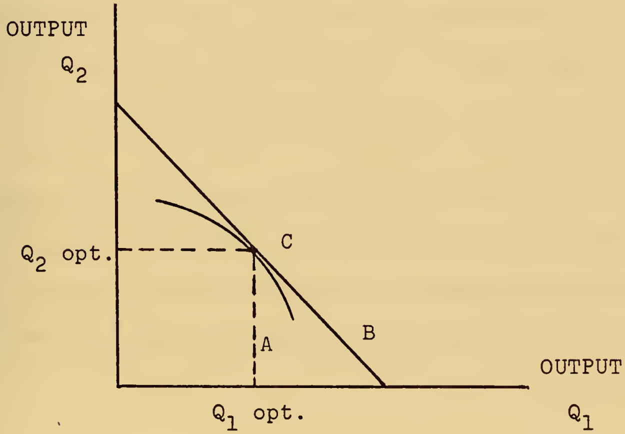


Figure 12. PRODUCTION TRANSFORMATION CURVE, VALUE LINE, AND OPTIMUM MIX

D. PRODUCTION POSSIBILITY CURVES

The production possibility curve is a locus of points showing the maximum attainable output of one commodity for every possible output of the other commodity while keeping a fixed resource base. Another name for production possibility curve is product transformation curve. Both refer to the same graphic description of production constrained by either dollars in a budget or resources available. The curve shows the relationship between two or more outputs subject to a single constraint. Generally, the trade-off between production of one good and another is not favorable and gives diminishing returns.

With a set constraint such as a budget, the only question remaining is at what combination of production is the value gained the greatest. The value gained may be found by using a value function that relates the value of two outputs.

$$\text{Value Function} = V = Q_1 + Q_2$$

Figure 12 depicts how this value function may be used to find the optimum mix of outputs Q_1 and Q_2. The optimum mix, Q_{1c} and Q_{2c}, is at the point of tangency between the transformation curve, A, and the value curve, B.

IV. PROBLEM SOLUTION

This section will look at the budget at NARFNI in non-quantitative terms. It will be shown how this budget can be transformed into a product transformation curve in terms of NARFNI output. This approach is possible by using Cobb-Douglas production functions and the Lagrange multiplier technique. The output is in terms of production load norms which bears a direct relationship to the repairing of aircraft, engines, and components.[7] This repair process will be referred to as production. The relationship between input resources, prices, and norms is found mathematically and then substituted into the budget equation. The budgets product transformation curve may be compared to other budget curves. First the data provided must be analyzed.

A. DATA ANALYSIS

The NARFNI production department supplied data from an observation period of approximately 19 months. Data used from this period covered only work inducted after January 1970 which was completed by approximately September 1971. The data as listed in Appendix A contains information about the work done on individual jobs. In order to look at the work performed daily and the cost of that work each day, an assumption was made that each job expended resources

[7] Naval Air Systems Command, NAVAIR INSTRUCTION 5220.2, Subject: Production Performance Report for Overhaul and Repair Departments, 12 October 1966. [Production Load Norms: Negotiated production expressed in terms of direct hours, determined at the quarterly Fleet Support Conference.]

uniformly over the days in shop. The number of days a job was in shop was figured from the difference between induction date and completion date. This number considered holidays or week-ends as regular days, so the days that actually were used to work on the job is unknown. For instance, if an engine was in NARF ten days for repair, each of the ten days would be credited with 10% of the labor man-hours, labor costs, material costs and norm.

Appendix B contains a program to pro-rate and graph the data over the observation period. The graphs show a cyclic effect to be present in the data with a rise and a fall approximately every 90 days. Little work was recorded on the first day and the last day. In the beginning of the period, some work was being done by the NARF on jobs in process before observation day one. At the end of our sample some jobs have been worked on but have not been completed. In both cases the data on the work are unavailable. Consequently, the observation period had to be shortened to eliminate the "start up" and "shut down" influence on the continuous production model [Figure 13].

The program listed in Appendix C was used to graph and analyze the empirical distribution of the number of jobs in NARF over the observation period. The objective of this program was to find a shortened period of observation with 95% confidence that "start up" and "shut down" influence had been eliminated. Each job was put in order by the

GRAPH OF PRORATED NORM (Y AXIS) VS DAYS (X AXIS) FOR AIRCRAFT

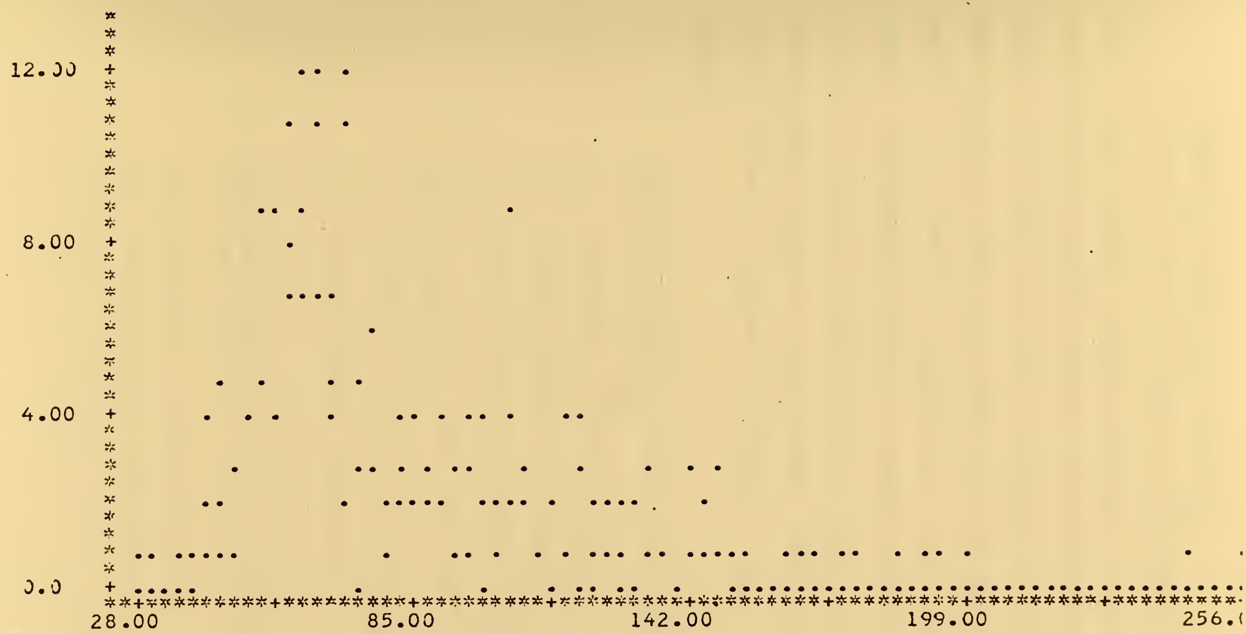
Figure 13. "START UP" AND "SHUT DOWN" EFFECT FROM DATA

number of days required to complete work. The first job on this ordered list took the fewest days for repair. When 95% of the jobs were ordered the number of days required to complete jobs at that point was recorded. The average number of days in shop, standard deviation, minimum and maximum number of days and the 95th percentile are all outputs from this program. An example of that output is depicted in Figure 14. The 95th percentile was used instead of trying to fit a known distribution to the date. The recorded number of days was then deducted from each end of the original observation period. The aircraft observations were cut by 122 on each end. The engines observations were cut by 47 on each end. The pro-rated data over the shortened observation period is the data used to determine the allocation of man-hours, labor costs, material costs and norm over time.

B. BUDGET EQUATION

The budget equation has two different types of variables, quantities of resources and price of those resources. The resources are labor, material and pipeline. They are used in the production of repaired aircraft, engines, and components. The budget is a dollar value allocated to production over a period of time.

$$(4\text{-}1) \quad \text{BUDGET} = B = P^L(L_1+L_2+L_3)+P^M(M_1+M_2+M_3) +P^P(P_1+P_2+P_3)$$



GRAPH OF NUMBER OF DAYS EACH JOB IS IN SHOP (AIRCRAFT)

MEAN= 83.58
STD DEV= 34.39
MIN NO. OF DAYS IN SHOP= 28.0
MAX NO. OF DAYS IN SHOP=256.0
95TH PERCENTILE OF ABOVE DISTRIBUTION = 122

Figure 14. DISTRIBUTION OF DAYS IN SHOP FOR AIRCRAFT

1. Resources Inputs and Subscripts

The labor input is measured by man-hours. Direct labor is that number of man-hours which can be accurately, feasibly or economically identified to the benefitting end-product. The material input is measured in dollars. The direct material costs are those which can be accurately, feasibly or economically identified to the benefitting end-product. The pipeline input is measured in job-days. Pipeline is the number of jobs present in shop. Each job in shop one day is equal to one job-day. For any specified period of time the number of job-days in shop can be calculated.

a. Aircraft production inputs are subscripted with the number 1.

L_1 = man-hours of direct labor on aircraft

M_1 = direct material costs used in aircraft

P_1 = number of aircraft days in shop

b. Engine production inputs are subscripted with the number 2.

L_2 = man-hours of direct labor on engines

M_2 = direct material costs used in engines

P_2 = number of engine days in shop

c. Component production inputs are subscripted with the number 3.

L_3 = man-hours of direct labor on components

M_3 = direct material costs used in components

P_3 = number of component days in shop

2. Prices

The price of labor is an average price of labor per hour. This price is found by aggregating all labor man-hours and dividing by the total labor costs. The price of labor in the production of aircraft, engines and components is the same. The price of material is equal to one because the resource input is in dollars expended on direct material. The price of pipeline is an average price of the job-day value. This is the price the Navy pays for not having the repairs completed. A civilian example would be the cost of "loaner" cars to an automobile dealer. The quicker the repair is completed, the less the cost. This price is found by dividing the replacement cost of the repaired job by the number of projected useful days after the repair is completed.

P^L = average price of labor per hour

$P^M = 1$

P^P = average price of pipeline per day

C. PRODUCTION FUNCTIONS

The production functions are Cobb-Douglas models of the production process at NARFNI. The function consists of constant parameters determined by historical data and previously defined labor, material and pipeline resources. The output of the functions is norm.

$$(4\text{-}2) \quad Q_1 = a_1 L_1^{\alpha_1} M_1^{\beta_1} P_1^{\gamma_1}$$

$$(4\text{-}3) \quad Q_2 = a_2 L_2^{\alpha_2} M_2^{\beta_2} P_2^{\gamma_2}$$

$$(4\text{-}4) \quad Q_3 = a_3 L_3^{\alpha_3} M_3^{\beta_3} P_3^{\gamma_3}$$

1. Ouput

Norm, the output of the production functions, is a flexible measurement of production and is in terms of man-hours required to repair one job. This number relates to the previous norm and is constantly being updated.

Q_1 = Aircraft norm

Q_2 = Engine norm

Q_3 = Component norm

2. Inputs

The same resources in the budget equation, L, M, and P are used in the production function. As previously defined, the subscripts, 1, 2, and 3 identify the resource used for repair of aircraft, engines and components respectively.

3. Parameters

The parameters use the same subscript scheme for reference to a particular output. The numerical value for the parameters a, α, β, γ is found by investigating the production data as presented in the production performance

reports. The estimation of these values is being done by concurrent thesis work using econometric techniques. The powers associated with each of the resources labor, material and pipeline are α, β, γ respectively. These resource parameters will generally be less than one which requires that the marginal product of an input decreases with increases in its utilization.[8] For an example, $L_1^{\alpha_1}$ means that if one percent of L_1 were added to production, that α percent increase in Q_1 would be gained.

D. LAGRANGE TECHNIQUE AND SOLUTION

From the problem:

$$\text{Min } B = P^L(L_1+L_2+L_3)+P^M(M_1+M_2+M_3)+P^P(P_1+P_2+P_3)$$

$$\text{S. T.} \quad Q_1 = a_1 L_1^{\alpha_1} M_1^{\beta_1} P_1^{\gamma_1}$$

$$Q_2 = a_2 L_2^{\alpha_2} M_2^{\beta_2} P_2^{\gamma_2}$$

$$Q_3 = a_3 L_3^{\alpha_3} M_3^{\beta_3} P_3^{\gamma_3}$$

The Lagrange Equation:

$$(4\text{-}5) \qquad (L,M,P,\lambda) = P^L(L_1+L_2+L_3) + P^M(M_1+M_2+M_3) + P^P(P_1+P_2+P_3) - \lambda_1(Q_1 - a_1 L_1^{\alpha_1} M_1^{\beta_1} P_1^{\gamma_1}) - \lambda_2(Q_2 - a_2 L_2^{\alpha_2} M_2^{\beta_2} P_2^{\gamma_2}) - \lambda_3(Q_3 - a_3 L_3^{\alpha_3} M_3^{\beta_3} P_3^{\gamma_3})$$

[8] Mansfield, p. 141.

Appendix E has six steps which were taken to use the Lagrange relationships to restate the budget equation in terms of output. Step five of Appendix E presents the outputs Q_1, Q_2 and Q_3 in terms of each resource raised to a power multiplied by a new constant.

$$Q_1 = AL_1^u = BM_1^u = CP_1^u$$

$$Q_2 = DL_2^v = EM_2^v = FP_2^v$$

$$Q_3 = GL_3^w = HM_3^w = JP_3^w$$

The budget equation (4-1) can be rewritten in terms of output as is done in step 6 of Appendix E. The result of the substitution is a non-linear relationship between Q_1, Q_2 and Q_3.

$$(4\text{-}6) \quad B = K_1(Q_1)^{\frac{1}{u}} + K_2(Q_2)^{\frac{1}{v}} + K_3(Q_3)^{\frac{1}{w}}$$

where K_1, K_2 and K_3 are constants.

If u, v and w were all equal to one, the relationship between outputs would be linear.

E. GRAPHICAL ANALYSIS

An iso-budget surface in three dimensional output space would represent the production possibility surface. However,

three dimensional graphs are difficult to draw as well as interpret. Consequently, only two outputs will be used, and the third will be set equal to zero in this sample analysis. The results can be extended to three dimensions. The budget in terms of aircraft and engine output only is:

$$(4\text{-}7) \quad B = K_1(Q_1)^{\frac{1}{u}} + K_2(Q_2)^{\frac{1}{v}} \;, \; Q_3 = 0$$

a non-linear product transformation equation. The slope of the product transformation curve is dependent on the values of u and v. Appendix F derives the second derivative in order to find whether the curve is convex or concave to the origin. The shape of the transformation curve will indicate increasing, constant or decreasing returns to scale [Figure 15]. The relationship between outputs is expected to be explained by the law of diminishing returns. This relationship is depicted by a concave product transformation curve.

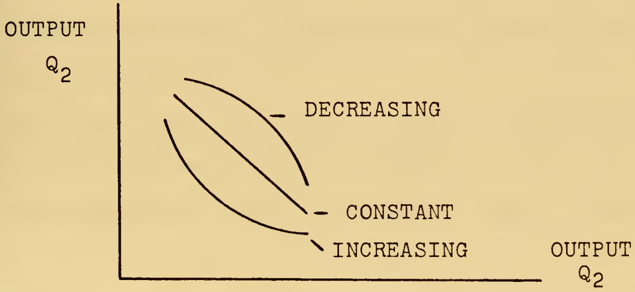


FIGURE 15. Product Transformation Curves, Returns to Scale

Engine output in terms of the budget and aircraft output is eq. (4-8). The second derivative of this expression

$$(4\text{-}8) \quad Q_2 = \left(\frac{B}{K_2} - \frac{K_1}{K_2}(Q_1)^{\frac{1}{u}}\right)^v$$

with respect to Q_1, aircraft output, will determine convexity or concavity. A concave curve will have a positive second derivative and the convex curve will have a negative second derivative. By inspection the sign of Q_2'' is controlled by the expression $B(u-1)+K_1(v-u)Q_1^{\frac{1}{u}}$. Substitute Eq. (4-7) for B and the sign of Q_2'' may be found by analyzing the expression

$$K_1Q_1(v-1) + K_2Q_2(u-1).$$

If u and v are both > 1 the curve is convex.

If u and v are both < 1 the curve is concave.

If u and v are both = 1 the change in slope is zero indicating linearity.

If the values of u and v are > 1 and < 1 respectively, the expression must be further evaluated.

The appropriate curve in Figure 15 can be drawn from Eq. (4-7). It should be interpreted only over the range of outputs that have been observed. In addition, the production data reveals that output of aircraft, engines and

components does not vary greatly from quarter to quarter. The three curves in Figure 15 are examples of possible product transformation curves. If the relationships derived and the data utilized are valid the product transformation curve should show all optimum combinations of production possible with a set budget.

A comparison may be made between before WIPICS and after WIPICS transformation curves [Figure 16]. These curves would have to represent the same total budget dollars and the prices of the resources and inputs would have to be expressed in constant dollars. Figure 17 depicts the situation where the better or worse evaluation question depends on the production output ranges. For example, better production would be achieved after WIPICS, only if $Q_1 \geq Q_{1a}$ and $Q_2 \leq Q_{2a}$. If while holding one output constant the new transformation curve provided more production of the other output the resultant savings would be that numerical increase in production multiplied by the value of output. Further analysis would be required to determine the exact dollar savings or loss after the purchase cost of WIPICS was deducted.

F. VALIDATION

The validation of the Cobb-Douglas production models used in this paper will be performed by a comparison of results with a linear economic model and the actual production results as documented at NARFNI. The Cobb-Douglas

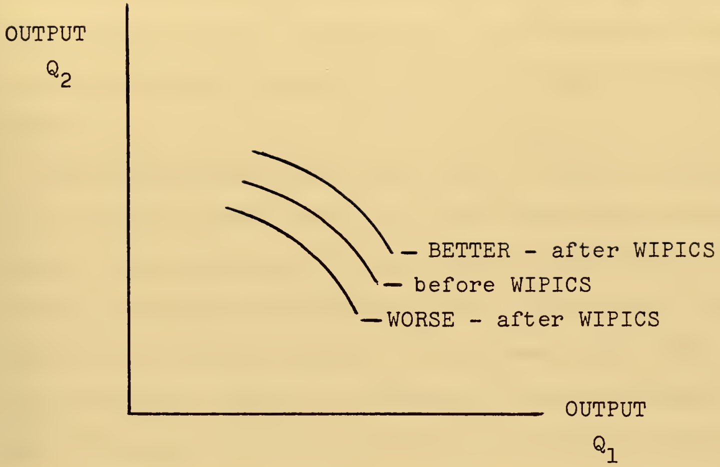


Figure 16. TRANSFORMATION CURVES, CLEAR RESULTS

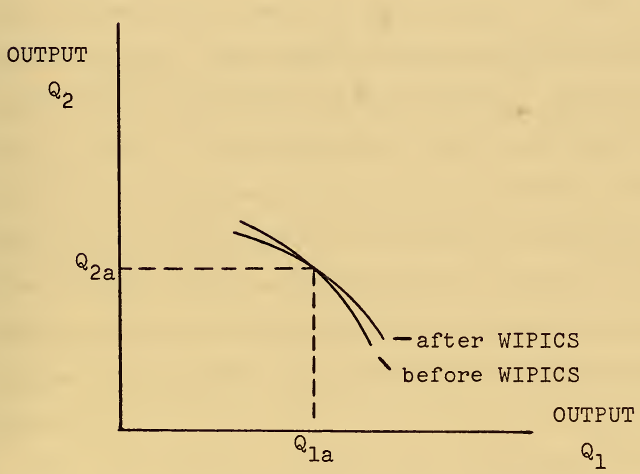


Figure 17. TRANSFORMATION CURVE, MIXED RESULTS

models are derived from the observed production data taken from the Production Performance Reports (PPR) for Fiscal Years 1970 and 1971. (Appendix A). Consequently, the comparison should be made only over the ranges of output observed.

Linear programming techniques may be used to formulate three linear economic models for the production programs at NARFNI. The objective functions will be the budget function and the constraints can be any number of documented relationships in the repair program. For instance, the engine production program consists of different repairs on different types of engines as well as different repairs on the same type engines. How these repairs are aggregated, if at all, will determine the number of constraints in the general linear program. The simplex algorithm must be used to solve the multi-variable linear program. Since the data used in the L.P. comes directly from the PPR and the data covers a two-year period of time, the linear economic models will closely model the production programs. All three linear models can be examined in detail by using sample production requirements and conducting parametric studies to determine the sensitivity of the solutions obtained.

The desirability of using the Cobb-Douglas production function over the general linear programming model lies in the simplicity of utilization of the former. Once the aggregation of the data has been done, the regression

coefficients in the Cobb-Douglas function are computed by applying the principle of least squares to the logarithmic values of the variables. This linear transformation is made because calculations of the coefficients are easier and statistical theory is primarily developed under the assumption of linearity.[9]

A comparison of the Cobb-Douglas production model, and the linear programming model can be made by comparing their product transformation curves to the actual production output. Cobb-Douglas and linear programming models should depict similar curves for equal budgets. For a particular budget the actual production will be a unique point as represented in figure 18. The area ABCD represents the area of possible output combinations after plotting historical ranges of each output. With the budget held at the same constant dollar level the comparison between models and

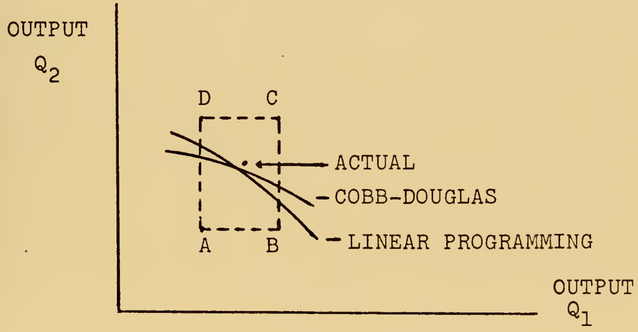


Figure 18. Validation of Transformation Curves

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[9]Chou, Ya-Lun, Statistical Analysis, New York: Holt, Rinehart and Winston, Inc., p. 657, 1969.

actual data is easier. The model curves can be compared for goodness of fit to a series of actual production points. The decision as to how well either curve should represent the data must be determined.

Another way to evaluate the accuracy of the models is in terms of constant outputs. This method will compare the budget for actual output with the budgets required for the models to match that output. The difference between the budget costs will give a measure of how close the models are to representing actual production. Many different actual production combinations can be considered and in each case the dollar difference in the required budgets can be measured. This form of comparison still requires a decision to be made about how close the budgets must be to the actual budget before the production models are accepted for use in the analysis.

V. CONCLUSIONS AND FUTURE STUDY

A. CONCLUSIONS

The initial efforts of this research paper were directed toward the analysis of data from the Production Performance Reports supplied by NARFNI. It was shown from the data that a problem existed with a "start up" and "shut down" effect. A method of eliminating that problem resulted in the pro-rating of the data in order to find an unaffected shortened period of observation. Once the observation period was determined, efforts were directed toward the determination of production functions which adequately represented the production process at NARFNI. Research revealed that the Cobb-Douglas production functions could be used to represent the entire NARFNI production process. Cobb-Douglas functions require coefficients of production which must be derived from the observed data. Determination of those coefficients can be accomplished by using econometric techniques. A linear programming model was proposed as a useful validation tool in addition to the comparison with actual data. The problem of establishing the validity of the models proposed is mentioned and possible approaches to finding solution are offered.

The solution to the problem as stated in this paper lies in the use of the product transformation curves. These curves can represent production in such a way that expensive,

time consuming measurements of many variables are not required and detailed relationships between shops and programs need not be analyzed. It has been shown that the production functions are sufficiently detailed to permit a mathematical look at the trade-offs between inputs. For example, the trade-off between labor, man-hours, and pipeline costs can be found given some level of output. It has been shown that the ultimate evaluation of WIPICS, before and after, can be made by comparison of the outputs from the constant dollar budget or the comparison of the budgets from the constant output.

B. FUTURE STUDY

The prototype WIPICS contract is not complete until the end of December 1972. Data from the period of time while WIPICS was being installed and personnel were learning the system should be considered as biased data. The best measure of the system would be to compare the 1970 and 1971 fiscal year production data against the data from 1974 and 1975. Even with the elimination of the phase in time, numerous factors could effect the data during the two different periods completely independent from WIPICS. NARF management and policy decisions on the national level as well as on the local level would have an effect on production regardless of the incorporation of WIPICS. The ultimate relevance of external factors would have to be decided and allowed for in the final WIPICS cost-benefit analysis.

An area that must be investigated is the actual dollar savings or loss from WIPICS. This dollar sum would have to consider the costs associated with new equipment, training, computer rental time and qualified technical personnel. Just how the exact cost can be formulated is no easy task and is made even more difficult by the changing prices of the resources and the ever-present inflationary losses.

1. Sensitivity Analysis

The model as developed in this paper can be easily modified by changing prices of inputs or quantities of resources. Also, if the budget were increased or decreased the changes in the product transformation curves could be studied. These adjustments to the model may provide insight to future production benefits or problems.

2. Cyclic Phenomenon

The graphs in Figure 13 and 14 display a cycle of production in the NARF data. An explanation of this may have a definite bearing on the pro-rated data and the subsequent use of that data in the production functions. The budget is reviewed quarterly and so is production planning. Possibly these events have an effect on the work-load in the NARF.

3. Computer Use

The programs in Appendix B and C could be combined in one program. This would give a graphic display of the basic data as well as a graph of the pro-rated data over

the shortened observation period. A comprehensive program could include the minimization of the budget subject to the production function constraints. The parameters required in the production functions could be solved by a regression model in the same program. The linear programming problem could be solved simultaneously with the minimization problem as presented in this paper. The results could then be viewed as a single computer output.

4. Different Models

Two other models of production should be considered. The constant elasticity substitution (CES) production function and the stochastic production function. The latter, a version of the Cobb-Douglas model, simulates uncertainty in production expectations. The stochastic model would have the advantage of being able to determine optimal factor inputs on the basis of an expected output constraint.

APPENDIX A. DATA

This appendix contains the raw data as received from NARFNI. The columns of the computer listing refer to the following information:

Column 1 - Special two digit thesis code for type A/C and engine.

Aircraft Type-Model-Series Codes

A/C	Code	A/C	Code
C-2A	10	SH-3A	33
E-2A/B	11	SH-3A/G	34
F-4J	21	SH-3D	35
F-4B	22	CH-46A	41
F-4G/B	23	CH-46D	42
F-8J	25	CH-46F	43
F-8H	26	UH-46A	44
RF-8G	27	UH-46D	45
CH-3B	31	CH-53A	48
RH-3A	32	CH-53D	49

Engine Type-Model-Series Codes

ENGINE	CODE
J57-P-4A/22	71
J57-P-10	72
J57-P-20A	73
J57-P-22	74
J57-P-420	75
J79-GE-8B	91
J79-GE-8B/C	92
J79-GE-8B(RDTE)	93
J79-GE-8B/C(RDTE)	94
J79-GE-10	95
T58-GE-1(A/F)	51
T58-GE-3(A/F)	53
T58-GE-5(A/F)	55
T56-A-8P	56
T58-GE-5(C/G)	57
T58-GE-8F	81
T58-GE-8B	82
T58-GE-8B/F	83
T58-GE-8B(C/G)	84
T58-GE-8B(HH2)	85
T58-GE-8B/F(CONV)	86
T58-GE-8B/F(RES)	87
T58-GE-10	89

T64-GE-3(A/F)	63
T64-GE-6B	65
T64-GE-6B(PAMN)	66
T64-GE-7(A/F)	67
T64-GE-413	69

Column 2 - Aircraft Bureau Number and Engine ID Number

Column 3 - Two Digit Rework Category and Par Cycle Number

Aircraft Categories and Cycles Numbers

A/C CATEGORY	FIRST DIGIT	SECOND DIGIT
Overhaul	1	Cycle Number
PAR	2	"
PAR/CONV	3	"
PAR/MOD	4	"
PAR/MOD/REP	5	"
PAR/REP	6	"
PAR/SEA/53	7	"
PAR/CONUS/53	8	"
New Additions	9	"

Engine Category

CATEGORY	CODE
Overhaul	01
Overhaul Conv.	02
PAR/REP	03

SUPPLY/REP 04

SUPPLY/REP/CONV 05

Column 4 - Induction Julian Date

Column 5 - Completion Julian Date

Column 6 - Norm

Column 7 - AFC Man-hours (A/C only)

Column 8 - Direct Man-hours

Column 9 - Direct Labor Cost

Column 10- Direct Material Cost

Column 11- Overhead Costs Applied

Column 12- NIF Hourly Rate

AIRCRAFT - RAW DATA

10	155124	41	0306	1031	8300	1241	8546	52253	17210	53745	1442
10	152794	42	1053	1159	10300	3897	10688	67190	33333	66556	1563
10	155122	42	1094	1181	8300	2863	7754	49212	19619	45905	1480
11	152482	32	0208	0320	10100	2300	9851	60106	28444	70364	1613
11	152487	32	0229	0329	10100	2601	9929	60126	23208	70474	1549
11	152489	32	1004	1110	11200	3020	12548	78750	36361	78291	1541
11	150531	33	0105	0201	10100	1958	10753	62152	25851	72035	1488
11	151713	33	0121	0229	10100	1978	12610	73711	26923	84930	1472
11	151722	33	0135	0252	10500	2370	12709	74641	33447	86210	1529
11	151714	33	0155	0307	15300	2089	15361	94326	38297	107658	1564
11	151716	33	0166	0281	13400	2205	15094	89602	41862	110507	1603
11	151717	33	0182	0292	12300	2154	12952	78254	38773	95832	1643
11	150539	33	0196	0327	12300	2115	14281	86708	33364	104020	1569
11	150532	33	0244	0350	10900	3060	11368	67986	33068	78033	1575
11	151721	33	0258	0365	12300	2547	12778	77568	34973	85069	1546
11	151719	33	0278	0365	12300	3138	13306	81115	27112	87631	1472
11	151715	33	0288	1029	12300	2495	14629	88811	28150	94660	1447
11	151720	33	0335	1072	11800	2586	13427	82295	29736	82839	1451
11	151712	33	0349	1089	12300	2587	12548	78017	30237	78920	1492
11	152476	33	1018	1126	11200	4222	12010	75380	36236	75278	1556
11	151718	33	1032	1133	11900	3228	12073	74654	37376	76676	1563
11	152447	33	1047	1156	11200	2881	11688	72362	36779	73540	1563
11	152481	33	1060	1166	11200	2768	11606	72469	38168	72884	1581
11	151708	34	0306	1047	12300	2589	11813	71406	28766	73281	1468
11	151703	34	0320	1064	11600	2634	15577	82608	28230	82145	1242
11	151704	34	1074	1175	11200	3004	13026	81558	38486	80686	1541
11	150540	34	1091	1197	11200	2848	12013	74104	28029	73587	1463
11	151702	34	1105	1210	11800	3016	12579	78641	24263	76811	1429
21	155810	11	0180	0352	15000		15418	93390	74677	98584	1729
21	155752	21	0153	0238	7408	1561	8883	53757	29116	60748	1617
21	155743	21	0155	0250	7282	1573	9539	58154	27951	65680	1591
21	155731	21	0159	0259	7603	1859	9770	59025	33317	67858	1640
21	155757	21	0161	0252	7269	1871	8584	52869	27404	59548	1629
21	155747	21	0163	0232	7296	1859	8540	51694	28619	59581	1638
21	155755	21	0167	0243	7004	2231	8815	53292	28327	61871	1628
21	155577	21	0170	0249	7905	1859	9010	55309	24151	63742	1589
21	155733	21	0177	0243	7172	1871	8229	49401	25436	59042	1627
21	155749	21	0182	0250	8300	2343	8328	50527	22402	59851	1594
21	155759	21	0183	0255	8300	912	8125	50283	25695	58226	1652
21	155766	21	0188	0250	8300	50	8017	49217	19323	57488	1572
21	155773	21	0190	0266	8300	62	8627	52400	20487	61837	1562
21	155768	21	0194	0264	8300	50	8465	52628	17977	60197	1545
21	155769	21	0196	0271	8300	62	7657	47351	18457	54527	1572

21	155765	21	0198	0264	8300	50	8323	51781	17908	59438	1551
21	155761	21	0202	0272	8300	62	7898	49006	19239	56956	1585
21	155764	21	0204	0273	8300	50	8446	52683	17814	60238	1548
21	155778	21	0209	0269	8300	2324	7657	47230	17233	54600	1555
21	155741	21	0210	0273	8300	50	8232	51013	17386	59209	1550
21	155753	21	0215	0273	7400	150	7087	43859	16720	49931	1559
21	155779	21	0218	0272	7400	2525	6613	40891	16726	46784	1579
21	155740	21	0239	0294	9100	1995	7940	48002	18506	54182	1520
21	155780	21	0246	0307	9100	1908	7983	48376	18492	53289	1505
21	153088	21	0288	0327	6300	1312	5282	32360	20957	31905	1613
21	155578	21	0299	0365	6900	2518	8416	52941	21832	52632	1514
21	153895	21	0301	0357	8200	1437	8168	52885	32326	49610	1651
21	153851	21	0329	1033	6900	2277	7414	46906	22924	44437	1543
21	155573	21	1004	1075	8200	1874	8371	53799	21763	50824	1510
21	155803	21	1007	1073	6900	1879	8203	52165	17516	49032	1447
21	155829	21	1011	1069	6900	1630	6839	44892	17262	41796	1520
21	155835	21	1019	1083	6900	1735	7882	51555	18395	48456	1502
21	155799	21	1022	1084	8150	1819	8658	57127	20591	53397	1514
21	155827	21	1025	1082	6900	1681	7267	47390	17779	44712	1512
21	155807	21	1027	1090	8100	1871	9060	59701	20994	57196	1522
21	155787	21	1029	1090	8100	1937	8058	53160	20858	50653	1547
21	155569	21	1035	1111	8100	1945	8895	56076	20260	54659	1473
21	155560	21	1042	1126	8800	1949	9248	59526	22511	57615	1510
21	155813	21	1049	1111	8000	1905	9742	62407	22361	46318	1346
21	155797	21	1055	1126	8100	1923	9116	57412	21882	56439	1489
21	155800	21	1064	1126	8200	1913	9611	60308	22901	60184	1492
21	155792	21	1084	1155	8100	1920	9717	60471	23646	60716	1491
21	155774	21	1090	1167	8100	2005	8902	46097	22312	45313	1277
21	153071	21	1113	1166	6300	1877	8336	54950	15061	51922	1463
21	155878	21	1180	1236	6800	1245	6312	40478	29794	42563	1788
21	153783	22	1069	1111	7600	2756	8056	50731	20576	49990	1506
21	155543	22	1069	1140	8100	1952	9414	58856	22667	58813	1491
21	155545	22	1081	1156	8100	1999	9572	59844	22672	59558	1484
21	153792	22	1124	1181	9000	2759	8356	55498	18584	54385	1537
21	153910	41	0097	0217	12000	1766	11580	68297	24406	77859	1473
21	153886	41	0104	0231	13676	2005	13436	79935	32101	91201	1513
21	153888	41	0113	0238	13577	2097	12899	77580	35828	86910	1553
21	153838	41	0120	0264	13486	2336	13564	81428	28154	91245	1481
21	154786	41	0134	0250	12000	1896	11459	68564	19676	77418	1446
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25	149137	21	1089	1175	6600	1052	7837	50289	24732	48671	1578
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43	156428	21	0191	0248	4000	528	3269	18919	11523	23972	1665
43	156430	21	0203	0271	4000	566	3205	19664	7718	24164	1608
43	156435	21	0215	0265	4000	404	2700	16472	7524	19763	1621
43	156433	21	0218	0264	4000	458	2650	15907	8873	19405	1667
43	156445	21	0222	0273	4000	558	2629	16093	7525	19392	1636
43	156441	21	0252	0299	4000	362	3031	17782	8416	20958	1556
43	156439	21	0260	0306	4000	566	3403	19825	8416	23221	1512
43	156442	21	0275	0321	4000	563	3277	18960	13727	21295	1647
43	156437	21	0287	0337	4000	576	3363	19612	13727	21696	1636
43	156448	21	0299	0343	4000	329	3290	19945	14233	21195	1683
43	156438	21	0307	0354	4000	576	3449	20883	13780	21453	1627
43	156447	21	0309	0350	4000	576	2899	17910	13386	17886	1712
43	156431	21	0334	1039	3200	544	3680	22843	11497	21927	1529
43	156432	21	0349	1030	3200	584	3123	19251	11410	19102	1593
43	156436	21	1004	1062	3200	288	3683	22934	14046	23001	1629
43	156440	21	1013	1069	3200	584	3401	21232	13857	21412	1661
43	156443	21	1034	1079	3200	554	2985	18989	14399	18769	1747
43	156444	21	1036	1086	3200	604	3188	20648	13841	20286	1718
43	156450	21	1049	1092	3200	332	2681	16695	14075	16907	1778
43	156451	21	1092	1138	3200	300	2804	17108	11119	17431	1628

43	156454	21	1104	1155	3200	289	3090	18719	11397	19256	1598
43	156453	21	1113	1172	3200	371	2887	18010	11410	17257	1617
43	156452	21	1138	1179	3300	424	3237	21829	11460	19576	1633
44	152495	23	1032	1086	4500	1181	4291	29007	15100	29174	1708
45	153412	22	0197	0255	4000	696	3161	18912	13378	23160	1754
45	153413	22	1020	1079	4000	892	3947	25461	19055	25727	1780
48	154882	21	0265	0328	4900	101	5426	31777	16744	36576	1568
48	154868	21	0279	0344	4900	150	5075	32980	38290	37440	2142
48	152402	22	0211	0275	4900	197	5115	30237	22933	38138	1785
48	152405	22	0224	0301	4900	201	5149	30875	15798	37608	1637
48	152403	22	0243	0303	4900	221	5242	31138	17319	37462	1639
48	152406	22	0258	0331	4900	247	5027	29107	17790	35034	1630
48	152410	22	0322	1028	4900	239	5968	37266	37810	36709	1873
48	154876	71	0141	0217	7800	104	9107	52128	62498	60663	1925
48	154879	71	0159	0226	7800	99	8352	47878	50993	57750	1878
48	151689	71	0182	0237	7800	92	6467	37390	26821	48566	1744
48	154880	71	0195	0260	7800	126	6785	39136	34381	50868	1833
48	152400	71	0201	0266	7800	160	5694	33626	25992	42489	1793
48	154870	71	0205	0266	7800	151	6560	38811	29153	49230	1786
48	151687	71	0271	0338	7800	157	5557	32875	25250	36876	1710
48	151698	72	0231	0300	7800	99	5696	34284	22113	41094	1712
48	151696	72	0251	0323	7800	157	6375	37020	25358	45374	1690
48	152409	72	0328	1039	7200	250	6386	40391	53798	39309	2090
48	152414	72	0341	1040	7200	368	6542	40284	54350	40536	2066
48	152408	72	0357	1055	7200	224	6221	38332	55545	33913	2151
48	152412	72	1011	1069	7200	294	7588	47839	49488	49945	1941
48	153275	72	1042	1104	6500	374	6768	41849	44897	43686	1927
48	153288	72	1067	1126	6500	493	7921	48353	46247	51558	1845
48	153274	72	1106	1172	6500	495	7641	47441	26529	47761	1593
48	153287	82	1132	1194	5500	535	5784	35585	24268	34777	1636
48	153293	82	1139	1208	5500	572	5897	36231	25492	34152	1626
48	153706	82	1155	1215	5500	437	5397	33353	25232	32095	1680
49	156654	21	1123	1176	5500	229	5298	33481	17220	32757	1575
49	156656	71	1169	1231	7000	157	7128	43771	21951	46631	1576

ENGINES — RAW DATA

51	2AN0101	01	0187	0226	400	373	2214	8282	3085	3641
51	2DN0101	01	1119	1147	470	419	2541	1749	2941	1726
51	2BN0301	04	0364	1026	260	242	1392	674	1709	1560
51	2CN0302	04	1012	1033	260	237	1503	524	1762	1599
53	2HN0124	01	0156	0189	340	482	2782	6388	3335	2594
53	2HN0308	01	0168	0198	410	201	1166	1168	1479	1897
53	2HN0125	01	0170	0212	410	508	2922	7700	3969	2872
53	2HN0309	01	0174	0202	410	251	1408	4690	1944	3204
53	2HN0301	01	0175	0229	410	392	2292	3187	3153	2202
53	2JN0301	01	0189	0218	200	140	797	1135	1127	2185
53	2JN0302	01	0190	0225	200	119	708	113	954	1492
53	2JN0101	01	0197	0240	400	447	2660	8943	3728	3430
53	2JN0102	01	0204	0245	400	432	2604	4449	3621	2471
53	2JN0103	01	0205	0245	400	436	2593	6773	3638	2983
53	2JN0303	01	0209	0236	200	185	1072	1277	1463	2061
53	2JN0304	01	0216	0252	200	257	1637	1427	2064	1995
53	2JN0305	01	0231	0259	200	139	838	1923	1139	2806
53	2JN0104	01	0231	0264	400	405	2385	8403	3377	3498
53	2JN0105	01	0233	0266	400	431	2626	7855	3664	3282
53	2KN0101	01	0285	0309	470	414	2512	2899	3028	2038
53	2KN0102	01	0287	0317	470	451	2660	3436	3322	2088
53	2KN0103	01	0289	0323	470	434	2586	6341	3195	2793
53	2KN0104	01	0293	0327	470	386	2237	3892	2803	2314
53	2KN0105	01	0294	0329	470	356	2115	6746	2612	3223
53	2KN0106	01	0299	0338	470	429	2469	5184	3146	2517
53	2KN0107	01	0302	0343	470	423	2474	5980	3109	2734
53	2KN0108	01	0306	0344	470	509	3022	2809	3781	1888
53	2KN0109	01	0309	0345	470	433	2582	3451	3196	2131
53	2KN0110	01	0317	0351	470	382	2367	2082	2913	1927
53	2KN0111	01	0364	1032	470	404	2523	3568	2951	2238
53	2KN0112	01	0365	1033	470	465	2838	3622	3395	2119
53	2LN0102	01	1005	1039	470	433	2676	7138	3187	3003
53	2LN0101	01	1007	1043	470	449	2697	3144	3290	2034
53	2LN0103	01	1008	1043	470	425	2582	5788	3101	2699
53	2LN0104	01	1022	1054	470	407	2511	935	2993	1582
53	2LN0105	01	1027	1061	470	488	3128	2777	3719	1972
53	2LN0106	01	1028	1057	470	411	2546	1037	3058	1616
53	2JN0306	04	0264	0288	260	169	934	2825	1261	2970
53	2JN0306	04	0264	0288	260	151	853	3422	1112	3568
53	2KN0301	04	0299	0321	260	175	1022	847	1205	1757
53	2KN0303	04	0355	1029	260	322	1976	1782	2338	1893
53	2KN0302	04	0356	1019	260	276	1662	2313	1964	2152
53	2KN0304	04	0357	1022	260	195	1172	655	1379	1644

53	2LN0301	04	1004	1032	260	270	1652	2961	1917	2419
55	2PP0102	01	0329	1012	470	562	3240	4950	4255	2214
55	2PP0301	04	0286	0309	260	185	1056	853	1281	1724
55	2PP0302	04	0289	0321	260	227	1308	2240	1589	2263
55	2PP0303	04	0296	0327	260	204	1187	1112	1426	1826
55	2PP0304	04	0310	0344	260	182	1131	2148	1281	2505
55	2PP0305	04	0320	0342	260	165	1265	890	1496	2213
55	2VP0301	04	1048	1062	260	184	1121	1022	1348	1897
55	2VP0302	04	1049	1069	260	206	1251	2154	1553	2407
55	2VP0303	04	1050	1070	260	231	1365	202	1750	1436
55	2VP0304	04	1055	1071	260	173	1084	2516	1389	2884
55	2VP0305	04	1056	1071	260	193	1196	455	1545	1651
55	2VP0306	04	1062	1091	260	256	1540	1409	2102	1973
55	2WP0301	04	1111	1131	260	150	883	418	1069	1580
55	2WP0302	04	1126	1153	260	230	1370	578	1574	1531
55	2WP0303	04	1127	1147	260	186	1098	509	1276	1550
56	28L0301	03	1176	1195	40	53	334	1270	282	3558
56	28L0302	03	1176	1195	40	43	268	1270	224	4098
56	25L0301	04	0216	0243	70	68	502	164	330	1465
56	25L0302	04	0236	0264	70	19	130	3393	103	19084
56	25L0303	04	0254	0299	70	16	97	164	107	2300
56	26L0301	04	0268	0307	70	33	215	874	207	3927
56	26L0302	04	0349	1019	70	75	454	2571	487	4682
57	2TP0301	01	0188	0218	160	194	1169	3475	1603	3220
63	2JT0101	01	0183	0245	640	902	5260	15831	7561	3176
63	2KT0101	01	0301	0346	754	659	3858	8382	4863	2595
63	2KT0302	04	0363	1026	371	425	2627	1122	3084	1608
65	24T0104	01	0163	0223	700	680	3945	23766	5043	4817
65	21T0101	01	0195	0244	700	865	5037	15241	7224	3179
65	21T0102	01	0218	0252	700	718	4346	8065	6122	2581
65	21T0103	01	0222	0254	700	616	3736	7986	5240	2754
65	21T0104	01	0224	0266	700	660	3955	8358	5518	2702
65	21T0106	01	0238	0294	700	690	4133	8158	5646	2600
65	21T0107	01	0239	0294	700	774	4566	11392	6293	2875
65	21T0105	01	0240	0292	700	588	3434	8909	4809	2917
65	21T0108	01	0271	0322	700	703	4092	7968	5196	2455
65	21T0109	01	0272	0313	700	677	3968	7975	5007	2504
65	22T0101	01	0286	0321	700	702	4228	15150	5180	3498
65	22T0102	01	0292	0345	700	645	3831	16042	4783	3823
65	22T0103	01	0317	0346	700	646	4039	20892	4896	4617
65	22T0104	01	0363	1029	700	765	4782	20318	5627	4016
65	24T0101	01	1153	1193	700	755	4605	14604	4923	3196
65	24T0102	01	1181	1214	700	737	4519	14551	5935	3393
65	25T0302	03	0189	0204	230	184	1064	3432	1517	3268
65	25T0301	03	0189	0216	230	274	1613	8985	2243	4686
65	25T0305	03	0201	0226	230	194	1166	3708	1589	3331
65	25T0306	03	0201	0236	230	354	2130	6969	2940	3401
65	25T0319	03	0205	0230	230	167	1005	3334	1336	3398

65	25T0308	03	0205	0240	230	286	1667	4042	2347	2817
65	25T0310	03	0211	0236	230	153	907	3322	1229	3567
65	25T0311	03	0211	0240	230	309	1842	3786	2557	2649
65	25T0313	03	0217	0240	230	187	1130	3921	1510	3509
65	25T0316	03	0230	0258	230	278	1731	3322	2305	2647
65	25T0325	03	0233	0268	290	239	1486	4187	2025	3221
65	25T0326	03	0236	0268	290	192	1269	4187	1638	3695
65	25T0320	03	0237	0257	230	243	1551	3322	2001	2829
65	25T0321	03	0237	0266	230	224	1455	3332	1935	2996
65	25T0333	03	0247	0287	230	289	1728	3322	2269	2533
65	25T0332	03	0247	0293	230	232	1370	3791	1780	2992
65	25T0335	03	0254	0289	230	252	1487	3322	1953	2683
65	25T0334	03	0254	0306	230	297	1697	3983	2343	2701
65	25T0338	03	0264	0299	330	330	1991	3791	2474	2502
65	25T0340	03	0271	0299	230	230	1367	469	1685	1531
65	25T0341	03	0271	0306	230	374	2220	469	2747	1453
65	26T0302	03	0275	0306	230	179	1134	4181	1252	3669
65	26T0301	03	0275	0313	230	344	2073	4181	2480	2539
65	26T0304	03	0285	0310	230	222	1315	4186	1590	3194
65	26T0305	03	0285	0313	230	298	1811	4181	2155	2734
65	26T0316	03	0329	0352	230	310	1914	4181	2355	2726
65	26T0315	03	0329	0356	230	347	2242	4181	2718	2634
65	26T0319	03	0337	0356	230	329	2165	4181	2565	2709
65	26T0320	03	0337	0356	330	341	2319	4181	2720	2704
65	26T0324	03	0356	1006	210	353	2223	3804	2625	2451
65	26T0328	03	0364	1022	210	280	1723	2435	1998	2199
65	26T0329	03	0365	1026	210	307	1891	2627	2212	2192
65	27T0302	03	1015	1041	210	278	1733	6479	1995	3672
65	27T0305	03	1049	1071	210	306	2000	6478	2519	3594
65	27T0306	03	1049	1074	210	382	2434	6478	3158	3160
65	27T0307	03	1161	1183	280	252	1518	2633	1590	2278
65	27T0309	03	1169	1183	280	210	1263	2633	1358	2502
65	27T0310	03	1173	1201	280	375	2284	2633	2721	2037
65	28T0320	04	0159	0182	290	332	1954	7438	2261	3510
65	28T0321	04	0161	0189	290	330	1949	1819	2302	1839
65	28T0318	04	0162	0182	290	160	944	584	1062	1619
65	28T0319	04	0162	0183	290	208	1199	842	1429	1668
65	28T0322	04	0168	0210	290	234	1417	3758	1745	2957
65	28T0323	04	0173	0205	290	222	1299	802	1694	1709
65	25T0303	04	0189	0217	290	287	1649	9392	2290	4645
65	25T0304	04	0190	0224	490	265	1573	7363	2198	4202
65	25T0307	04	0196	0237	290	301	1780	4967	2474	3063
65	25T0312	04	0208	0243	290	261	1541	4427	2125	3101
65	25T0317	04	0223	0247	290	392	2354	4187	3254	2499
65	25T0318	04	0225	0252	290	195	1253	4187	1605	3613
65	25T0319	04	0231	0254	290	230	1421	4187	1886	3258
65	25T0322	04	0232	0265	290	195	1222	4187	1653	3622
65	25T0323	04	0232	0268	290	244	1569	4187	2108	3223

65	25T0324	04	0233	0265	290	287	1790	4187	2407	2921
65	25T0327	04	0236	0281	290	283	1727	4187	2247	2884
65	25T0328	04	0238	0280	290	213	1258	4187	1642	3327
65	25T0329	04	0239	0300	290	242	1435	4656	1896	3300
65	25T0330	04	0240	0281	290	333	1937	4186	2618	2625
65	25T0331	04	0245	0309	290	251	1478	4921	1935	3320
65	25T0336	04	0258	0288	290	281	1633	4187	2146	2835
65	25T0337	04	0260	0294	290	284	1697	4186	2132	2822
65	25T0342	04	0266	0328	290	342	2009	4826	2557	2746
65	25T0343	04	0267	0299	290	285	1728	4656	2103	2978
65	26T0303	04	0279	0308	290	255	1552	5280	1833	3398
65	26T0306	04	0293	0329	290	337	2066	5394	2434	2936
65	26T0307	04	0295	0338	290	274	1665	5280	1954	3248
65	26T0308	04	0299	0328	290	245	1423	5280	1751	3451
65	26T0309	04	0300	0329	290	301	1753	5280	2170	3057
65	26T0310	04	0302	0338	290	310	1931	5280	2259	3055
65	26T0311	04	0303	0339	290	253	1567	5280	1815	3424
65	26T0312	04	0307	0363	290	386	2482	5280	2897	2761
65	26T0313	04	0309	0320	290	80	501	5280	542	7904
65	26T0314	04	0324	0352	290	270	1706	5280	2043	3344
65	26T0317	04	0328	0353	290	260	1699	5280	2002	3454
65	26T0318	04	0329	0357	290	327	2450	5280	2867	3241
65	26T0321	04	0342	1004	280	432	2751	5286	3240	2610
65	26T0322	04	0346	1011	280	365	2258	5094	2704	2755
65	26T0325	04	0349	1013	280	313	1969	5094	2293	2989
65	26T0326	04	0350	1021	280	276	1775	8970	1989	4614
65	26T0327	04	0356	1021	280	315	1977	8970	2306	4207
65	26T0330	04	0365	1036	280	349	2222	9223	2512	3999
65	27T0301	04	1005	1028	280	359	2210	7592	2591	3452
65	27T0304	04	1012	1047	280	246	1570	7522	1742	4412
65	27T0303	04	1015	1076	280	479	2990	7543	3629	2957
65	27T0307	04	1071	1098	280	346	2116	8037	2744	3727
65	27T0309	04	1075	1104	280	332	2006	7449	2586	3627
65	27T0308	04	1075	1112	280	480	2926	8341	3818	3143
65	27T0310	04	1085	1120	280	470	2846	7668	3512	2984
65	27T0311	04	1090	1117	280	409	2454	7449	2998	3154
65	28T0301	04	1113	1140	280	413	2493	2608	2960	1952
65	28T0302	04	1117	1140	280	295	1791	2505	2081	2162
65	28T0304	04	1141	1166	280	281	2042	2505	2134	2378
65	28T0305	04	1146	1169	280	315	2462	2505	2558	2389
66	2EB0301	04	0166	0194	290	206	1209	580	1497	1595
66	2EB0302	04	0167	0196	290	305	1764	1489	2295	1819
66	2E90304	04	0266	0310	250	286	1695	3925	2129	2709
66	2ER0301	04	0267	0310	290	281	1675	8208	2069	4253
66	2ER0302	04	0273	0308	290	293	1700	4312	2122	2776
66	2E90305	04	0351	1020	280	346	2198	381	2531	1477
66	2E90306	04	0353	1019	280	351	2220	4831	2549	2735
66	2E90309	04	1006	1040	280	340	2091	5992	2446	3097

66	2E90307	04	1007	1036	280	414	2655	7207	3114	3134
66	2E90308	04	1008	1061	280	570	3541	368	4194	1422
66	2E90310	04	1022	1068	280	473	2926	12724	3553	4060
66	2EW0301	04	1118	1145	280	289	1727	4140	2056	2742
67	2DW0103	01	0180	0238	630	638	3687	21172	5332	4732
67	2KW0101	01	0310	0365	754	806	5047	21266	6113	4023
67	2KW0102	01	0320	0353	754	513	3260	20044	3983	5319
67	2LW0101	01	1029	1076	754	502	3101	31965	3751	7732
67	2KW0301	04	0275	0317	371	271	1613	3728	1929	2683
67	2KW0302	04	0275	0324	371	260	1525	918	1866	1657
67	2KW0303	04	0306	0346	371	228	1497	915	1653	1783
67	2KW0304	04	0308	0313	371	134	778	2031	965	2816
67	2KW0305	04	0316	0343	371	256	1598	1107	1913	1804
67	2KW0306	04	0329	0358	371	235	1648	2674	1810	2609
67	2KW0307	04	0358	1025	371	308	1922	2014	2223	2000
67	2LW0301	04	1020	1050	371	256	1606	30762	1820	13354
67	2LW0303	04	1036	1077	371	319	1995	16063	2414	6417
67	2LW0304	04	1053	1071	371	159	1009	717	1784	1830
67	2LW0305	04	1061	1091	370	278	1757	22190	2252	9420
69	24W0102	01	0145	0222	660	746	4340	46099	5296	7471
69	22W0101	01	0281	0353	660	586	3434	29589	4313	6371
69	22W0102	01	0295	0363	660	565	3733	29766	4607	6744
69	22W0103	01	0313	0350	660	467	2834	29338	3481	7634
69	23W0101	01	1018	1053	700	683	4266	30367	5057	5811
69	23W0102	01	1028	1070	700	559	3485	29763	4194	6698
69	23W0103	01	1047	1084	700	513	3307	29972	4368	7339
69	23W0104	01	1067	1123	700	737	4475	32043	5930	5760
69	23W0105	01	1077	1123	700	622	3755	30405	4813	6266
69	23W0106	01	1081	1116	700	581	3778	34190	4810	7363
69	24W0101	01	1123	1166	700	609	3777	20529	4390	4712
69	24W0102	01	1142	1182	700	550	3305	26063	3530	5981
69	24W0103	01	1174	1202	700	525	3140	26309	3987	6369
69	24W0104	01	1176	1211	700	633	3772	25933	4970	5478
69	28W0301	03	1176	1203	280	231	1388	4827	1733	3441
69	28W0303	03	1180	1208	280	226	1355	4827	1680	3479
69	25W0301	04	0154	0233	230	420	2345	32135	3369	9012
69	28W0303	04	0169	0226	210	387	2270	35367	3017	10505
69	25W0302	04	0202	0253	230	337	1998	23282	2673	8295
69	25W0303	04	0265	0295	230	245	1448	10566	1825	5649
69	26W0301	04	0288	0328	230	235	1400	12600	1644	6657
69	26W0302	04	0321	0351	230	247	1569	12600	1795	6463
69	26W0303	04	0322	0353	230	231	1473	12926	1708	6973
69	26W0304	04	0323	0352	230	258	1661	12599	1894	6261
69	27W0301	04	1011	1039	360	312	1913	14168	2240	5872
69	27W0302	04	1013	1047	360	222	1414	14154	1557	7714
69	27W0303	04	1055	1083	360	308	2051	14214	2574	6117
69	27W0304	04	1060	1091	360	261	1596	14163	2170	6869
69	28W0304	04	1180	1214	300	314	1897	5416	2458	3111

72	25B0301	04	0201	0254	600	741	4439	19510	6179	4066
72	28B0301	04	1181	1211	450	513	3212	18032	4045	4930
73	25D0307	03	0196	0229	320	362	2132	2367	2992	2069
73	25D0310	03	0208	0230	320	507	2975	1815	4146	1763
73	25D0311	03	0212	0243	320	580	3441	1815	4820	1737
73	25D0315	03	0229	0251	320	272	1615	1815	2249	2088
73	25D0324	03	0260	0282	320	194	1133	1815	1519	2303
73	25D0325	03	0271	0296	320	261	1527	1815	1937	2023
73	26D0311	03	0282	0306	320	158	0978	2279	1149	2789
73	26D0312	03	0288	0308	320	236	1469	2279	1729	2321
73	26D0321	03	0313	0343	320	216	1536	2906	1662	2826
73	27D0316	03	1089	1120	320	225	1358	10394	1645	5954
73	28D0334	04	0140	0182	430	645	3764	7338	4325	2392
73	28D0340	04	0160	0182	430	733	4234	6665	5015	2171
73	28D0336	04	0161	0191	430	568	3291	4156	4063	2026
73	28D0341	04	0162	0190	430	709	4125	9484	4987	2623
73	28D0343	04	0163	0182	430	317	1882	4233	2132	2602
73	28D0344	04	0167	0202	430	646	3725	4108	4800	1956
73	28D0345	04	0168	0194	430	336	1938	9264	2363	4037
73	28D0346	04	0169	0201	400	584	3486	8218	4380	2754
73	28D0348	04	0173	0202	400	424	2488	4121	3203	2314
73	28D0349	04	0174	0196	430	264	1591	4103	2034	2927
73	28D0350	04	0180	0203	400	430	2542	4289	3388	2377
73	28D0351	04	0181	0211	400	841	4971	8730	6916	2451
73	25D0302	04	0182	0215	500	381	2236	2837	3122	2151
73	25D0304	04	0188	0211	500	428	2557	3512	3494	2234
73	25D0305	04	0189	0224	500	765	4548	3987	6374	1949
73	25D0306	04	0190	0217	500	426	2451	2991	3461	2090
73	25D0309	04	0203	0244	500	612	3660	3650	5054	2020
73	25D0313	04	0210	0229	500	510	3057	2837	4197	1979
73	25D0314	04	0216	0244	500	561	3304	2837	4592	1913
73	25D0318	04	0229	0251	500	298	1889	2837	2498	2424
73	25D0322	04	0252	0303	500	1044	6038	2837	8204	1636
73	25D0323	04	0253	0281	500	526	3018	2837	4173	1906
73	25D0326	04	0260	0289	500	607	3510	2837	4662	1814
73	25D0327	04	0261	0292	500	552	3193	2837	4255	1863
73	25D0328	04	0272	0306	500	483	2836	2837	3507	1901
73	25D0330	04	0273	0303	500	451	2641	3329	3256	2046
73	26D0301	04	0274	0307	500	277	1650	3549	1971	2588
73	26D0304	04	0281	0317	500	685	3953	3549	4972	1821
73	26D0305	04	0282	0310	500	639	3698	3549	4636	1860
73	26D0306	04	0286	1011	500	500	2905	3549	3643	2019
73	26D0307	04	0287	0313	500	467	2813	3543	3326	2073
73	26D0308	04	0288	0320	500	443	2570	3550	3143	2091
73	26D0314	04	0294	0320	500	410	2390	3549	2975	2174
73	26D0313	04	0295	0317	500	396	2316	3549	2799	2188
73	26D0315	04	0296	0353	500	606	3707	3549	4452	1932
73	26D0316	04	0301	0345	500	244	1455	3550	1792	2786

73	26D0317	04	0302	0327	500	604	3536	3549	4383	1899
73	26D0318	04	0303	0336	500	736	4286	3549	5335	1789
73	26D0320	04	0314	0345	500	485	2894	3564	3574	2068
73	26D0324	04	0322	0353	500	414	2699	4551	3152	2513
73	26D0325	04	0328	0352	500	465	3119	3549	3669	2223
73	26D0326	04	0337	0357	500	482	3310	4563	4002	2464
74	25E0301	03	0190	0217	200	248	1472	6427	2011	3996
74	25E0308	03	0267	0289	200	159	0964	5043	1161	4508
74	27E0302	03	1019	1055	200	230	1416	6011	1664	3953
74	27E0303	03	1048	1078	200	289	1813	6012	2369	3527
74	27E0304	03	1054	1078	200	191	1214	3354	1534	3199
74	27E0324	03	1060	1082	200	084	0528	3354	0727	5487
74	27E0306	03	1076	1120	200	303	1902	3355	2267	2483
74	25E0303	04	0204	0229	400	319	1880	6614	2562	3466
74	25E0304	04	0215	0238	400	417	2473	4215	3374	2413
74	25E0305	04	0232	0268	400	534	3234	4215	4369	2213
74	25E0306	04	0238	0265	400	434	2730	4215	3507	2408
74	25E0307	04	0245	0268	400	460	2701	4215	3721	2312
74	25E0309	04	0265	0300	400	480	2756	10058	3580	3415
74	25E0310	04	0267	0317	400	494	2929	10057	3629	3363
74	26E0301	04	0310	0353	400	570	3489	9156	4230	2961
75	26D0309	03	0280	0303	320	106	0650	2279	0749	3470
75	26D0322	03	0329	0357	320	267	1745	2906	2046	2508
75	26D0329	03	0353	1011	400	202	1247	3639	1497	3152
75	26D0328	03	0364	1025	400	288	1787	3639	2106	2615
75	27D0301	03	1005	1047	400	393	2420	5342	2867	2705
75	27D0305	03	1041	1065	400	420	2630	5203	3187	2624
75	27D0312	03	1070	1102	320	279	1728	6117	2183	3593
75	28D0303	03	1103	1127	320	238	1469	3935	1686	2979
75	28D0304	03	1117	1139	320	200	1208	3935	1449	3296
75	28D0305	03	1125	1142	320	227	1445	3935	1585	3068
75	28D0337	04	0145	0194	430	510	3133	4176	3664	2152
75	25D0303	04	0187	0196	500	319	2054	9451	2607	4424
75	25D0308	04	0194	0223	500	656	3862	7683	5372	2579
75	25D0317	04	0224	0254	500	542	3226	2837	4416	1933
75	25D0320	04	0231	0253	500	409	2545	2837	3384	2143
75	25D0319	04	0231	0254	500	507	3146	2870	4251	2025
75	25D0321	04	0236	0265	500	571	3773	2837	5016	2036
75	26D0303	04	0279	0306	500	407	2461	3549	2896	2188
75	26D0310	04	0281	0316	500	442	2579	3549	3212	2113
75	26D0319	04	0309	0352	500	373	2198	3549	2674	2258
75	26D0323	04	0321	0338	500	224	1481	3549	1725	3016
75	26D0327	04	0355	1049	480	280	1757	3639	2045	2658
75	26D0330	04	0362	1028	480	555	3464	4419	4001	2141
75	27D0302	04	1021	1061	480	515	3218	5203	3673	2348
75	27D0303	04	1026	1078	480	538	3331	7665	4036	2794
75	27D0306	04	1032	1139	450	581	3655	6017	4224	2392
75	27D0307	04	1048	1076	480	639	4032	5202	5024	2231

75	27D0308	04	1054	1091	450	404	2536	5203	3186	2704
75	27D0309	04	1063	1077	480	240	1567	5202	1906	3615
75	27D0310	04	1064	1092	450	358	2207	4894	2923	2800
75	27D0314	04	1067	1077	480	168	1088	5202	1379	4565
75	27D0315	04	1078	1099	450	349	2095	5203	2650	2850
75	28D0301	04	1096	1146	450	466	2832	3935	3304	2161
75	28D0302	04	1098	1125	450	396	2445	5608	2781	2736
75	28D0306	04	1119	1146	450	418	2588	5608	2964	2670
75	28D0307	04	1120	1148	450	409	2567	5608	2802	2684
75	28D0308	04	1126	1155	450	358	2269	5708	2328	2878
75	28D0310	04	1132	1166	450	414	2732	14568	2624	4813
75	28D0309	04	1134	1169	450	268	1833	5608	1816	3454
75	28D0311	04	1147	1168	450	368	2434	5608	2279	2805
75	28D0313	04	1155	1201	490	678	4126	8208	4506	2484
75	28D0314	04	1163	1201	490	642	3942	8208	4417	2581
75	28D0315	04	1175	1203	490	340	2058	8208	2531	3764
81	21R0101	01	0188	0240	400	414	2682	7610	3858	3050
81	21R0102	01	0195	0231	400	411	2461	5390	3391	2735
81	21R0103	01	0203	0243	400	493	2975	5134	4100	2476
81	22R0101	01	0288	0322	400	422	2436	7779	3017	3136
81	23R0101	01	1089	1116	420	364	2187	4151	2706	2485
81	28N0324	03	0180	0215	170	171	938	941	1376	1904
81	27R0303	03	1041	1053	160	103	656	1358	741	2675
81	27R0304	03	1041	1055	160	102	627	1398	729	2700
81	27R0305	03	1070	1077	160	168	1103	1359	1463	2363
81	27R0306	03	1070	1078	160	144	914	1359	1223	2428
81	27R0307	03	1078	1091	160	91	552	1359	717	2888
81	27R0308	03	1078	1092	160	124	744	1359	982	2488
81	26R0301	04	0296	0316	220	129	790	1653	893	2586
81	26R0302	04	0321	0339	220	143	897	1653	1041	2511
81	26R0303	04	0365	1020	220	132	781	1689	907	2558
81	27R0301	04	1006	1022	220	157	937	1993	1098	2566
81	27R0302	04	1021	1040	220	87	537	1888	580	3454
81	27R0309	04	1085	1102	220	121	734	1888	877	2892
82	25N0301	03	0187	0202	100	130	777	1343	1059	2445
82	25N0302	03	0187	0202	100	157	880	535	1241	1692
82	25N0304	03	0196	0205	100	123	683	554	1012	1828
82	25N0305	03	0223	0230	100	138	836	351	1109	1701
82	25N0306	03	0223	0236	100	169	1034	351	1373	1632
82	25N0307	03	0231	0240	100	108	630	351	862	1706
82	25N0308	03	0231	0254	100	286	1707	351	2384	1553
82	25N0309	03	0245	0258	100	120	742	351	1007	1750
82	25N0310	03	0245	0264	100	209	1235	351	1668	1557
83	24N0205	02	0154	0182	470	436	2553	4393	3053	2293
83	24N0207	02	0159	0194	470	419	2414	7292	3011	3035
83	24N0206	02	0160	0194	470	474	2724	6025	3469	2578
83	24N0208	02	0161	0203	400	461	2658	6939	3349	2808
83	24N0209	02	0162	0212	400	572	3303	6919	4384	2553

83	24N0210	02	0163	0203	400	456	2643	6778	3439	2820
83	24N0211	02	0167	0211	400	423	2470	7087	3190	3013
83	24N0212	02	0169	0217	400	466	2743	7205	3572	2901
83	24N0213	02	0173	0216	400	425	2434	6388	3331	2860
83	24N0216	02	0174	0222	400	534	3161	4483	4329	2242
83	24N0214	02	0175	0219	400	474	2712	5080	3741	2433
83	24N0217	02	0176	0224	400	457	2733	8274	3697	3218
83	24N0218	02	0181	0237	400	432	2523	3736	3571	2275
83	21N0201	02	0204	0254	400	458	2727	4625	3811	2437
83	21N0202	02	0205	0252	400	410	2482	4411	3410	2513
83	21N0203	02	0224	0259	400	493	2508	3773	3402	1964
83	21N0204	02	0229	0261	400	430	2487	3772	3519	2274
83	21N0205	02	0236	0264	400	465	2716	3916	3832	2250
83	21N0206	02	0239	0267	400	453	2622	3809	3687	2234
83	21N0207	02	0247	0280	400	468	2717	3775	3772	2193
83	21N0208	02	0253	0287	400	421	2388	4111	3282	2323
83	21N0209	02	0258	0289	400	362	2077	4111	2816	2487
83	21N0210	02	0266	0296	400	392	2299	4111	2937	2384
83	21N0211	02	0271	0309	400	434	2553	4111	3224	2278
83	22N0201	02	0279	0310	400	433	2519	7569	3179	3064
83	22N0202	02	0286	0314	400	420	2514	7569	3092	3137
83	22N0203	02	0293	0324	400	440	2567	7569	3234	3039
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83	22N0205	02	0300	0338	400	376	2225	7569	2745	3335
83	22N0206	02	0307	0344	400	437	2647	7569	3197	3069
83	22N0207	02	0307	0345	400	399	2288	7569	2936	3206
83	22N0208	02	0313	0349	400	377	2225	7569	2820	3346
83	22N0209	02	0320	0353	400	410	2658	7569	3252	3288
83	22N0210	02	0327	1004	470	467	2862	12167	3509	3970
83	22N0211	02	0334	1020	470	534	3217	12181	4006	3634
83	22N0212	02	0343	1014	470	446	2686	9598	3335	3502
83	23N0201	02	1005	1039	470	499	3106	4652	3667	2290
83	23N0202	02	1012	1048	470	380	2426	4634	2760	2584
83	23N0203	02	1018	1048	470	403	2491	4633	2964	2503
83	23N0204	02	1019	1050	470	397	2457	4662	2909	2526
83	23N0205	02	1020	1053	470	363	2178	4634	2663	2610
83	23N0206	02	1026	1053	470	462	2916	4633	3431	2377
83	23N0207	02	1028	1069	470	443	2705	5001	3322	2489
83	23N0208	02	1029	1056	470	350	2156	4633	2565	2673
83	23N0209	02	1039	1067	470	394	2550	4633	3118	2614
83	23N0210	02	1041	1070	470	415	2595	4835	3245	2572
83	23N0211	02	1053	1091	420	482	2958	4249	3940	2313
83	23N0212	02	1061	1091	420	452	2734	4151	3711	2344
83	24N0201	02	1103	1126	420	374	2234	11848	2739	4498
83	24N0202	02	1111	1138	420	385	2321	11848	2791	4405
83	24N0203	02	1117	1145	420	372	2248	12222	2664	4606
83	24N0204	02	1134	1163	420	426	2601	11935	2840	4079
83	24N0205	02	1140	1168	420	345	2149	11883	2332	4740

83	24N0206	02	1141	1173	420	379	2420	11848	2570	4443
83	24N0207	02	1147	1183	420	404	2473	11848	2534	4172
83	24N0208	02	1180	1208	420	363	2190	11914	2891	4682
83	28N0211	04	0163	0196	260	265	1567	1346	1917	1823
83	28N0212	04	0168	0203	260	304	1787	2643	2250	2197
83	28N0213	04	0169	0202	260	336	1942	4037	2542	2536
83	28N0214	04	0173	0208	260	228	1349	963	1672	1747
83	28N0215	04	0173	0211	260	273	1607	1011	2142	1744
84	2GJ0101	01	0215	0245	450	367	2206	8324	3014	3690
84	2GM0101	01	0217	0265	450	417	2415	6226	3471	2905
84	2GS0101	01	0260	0296	450	396	2320	4757	3044	2556
84	2GT0101	01	0268	0300	450	423	2438	8143	3151	3246
84	2GV0101	01	0289	0328	450	433	2545	4112	3193	2275
84	2GW0101	01	0292	0322	450	394	2314	5473	2897	2712
84	2GX0101	01	0303	0346	450	434	2619	5128	3219	2527
84	2GZ0101	01	0337	1007	390	452	2658	6807	3385	2843
84	2GB0101	01	1021	1050	390	377	2329	4567	2766	2563
84	2GA0101	01	1070	1109	410	493	2901	6522	3926	2708
84	2GC0101	01	1071	1111	410	446	2664	6240	3511	2784
84	2GF0301	04	0166	0182	220	197	1112	1413	1358	1971
84	2GG0301	04	0166	0195	220	207	1178	1706	1441	2089
84	2GH0301	04	0201	0243	220	281	1681	1711	2271	2015
84	2GK0301	04	0218	0245	220	169	1021	775	1355	1864
84	2GL0301	04	0233	0257	220	191	1100	1260	1558	2051
84	2GR0301	04	0247	0274	220	240	1339	1897	1927	2151
84	2GU0301	04	0280	0309	220	146	873	651	1050	1763
84	2GY0301	04	0324	0352	220	248	1542	865	1901	1737
84	2GD0301	04	1142	1163	220	178	1097	297	1125	1415
85	2AR0101	01	0208	0252	450	543	3268	4857	4541	2333
85	2AR0102	01	0209	0245	450	451	2669	4987	3768	2533
85	2AR0103	01	0210	0253	450	464	2705	3650	3875	2205
85	2AR0104	01	0211	0260	450	432	2582	4940	3613	2578
85	2AR0105	01	0212	0254	450	420	2497	4069	3499	2396
85	2AR0106	01	0216	0246	450	443	2673	4731	3731	2514
85	2AR0107	01	0217	0265	450	436	2568	6301	3631	2867
85	2AR0108	01	0218	0266	450	420	2555	4890	3558	2620
85	2AR0109	01	0219	0264	450	453	2658	6551	3736	2858
85	2AR0110	01	0253	0288	450	492	2795	10820	3830	3546
85	2AR0111	01	0254	0282	450	508	2871	9557	3983	3231
85	2AR0112	01	0272	0302	450	424	2507	8017	3123	3219
85	2AR0113	01	0273	0303	450	440	2637	6709	3215	2855
85	2BR0101	01	0296	0329	450	424	2468	3523	3099	2144
85	2BR0102	01	0302	0339	450	425	2467	2023	3117	1790
85	2BR0103	01	0308	0346	450	375	2260	2608	2778	2039
85	2BR0104	01	0310	0346	450	416	2512	2335	3093	1909
85	2BR0105	01	0316	0351	450	395	2411	1935	2956	1849
85	2BR0106	01	0328	1004	450	475	2829	6801	3527	2770
85	2BR0107	01	0345	1019	450	423	2569	3561	3155	2195

85	2BR0108	01	0346	1019	450	431	2591	1515	3168	1688
85	2BR0109	01	0350	1019	450	406	2483	1966	2999	1834
85	2BR0110	01	0351	1028	450	543	3362	5986	4009	2460
85	2BR0111	01	0357	1029	450	401	2486	4294	2937	2423
85	2BR0112	01	0363	1029	450	415	2572	2480	3020	1945
85	2CR0101	01	1006	1043	450	381	2341	4830	2794	2615
85	2CR0102	01	1013	1050	450	431	2639	7620	3166	3115
85	2CR0103	01	1063	1102	430	465	2801	5165	3770	2524
85	2CR0104	01	1068	1102	430	396	2387	7322	3214	3263
85	2CR0105	01	1075	1109	430	430	2580	5700	3403	2717
85	2CR0106	01	1078	1109	430	411	2465	8469	3227	3445
85	2CR0107	01	1082	1111	430	348	2053	4778	2653	2725
85	2DR0101	01	1091	1116	430	289	2350	2847	2862	2789
85	2DR0102	01	1105	1135	430	413	2475	9644	3005	3662
85	2DR0103	01	1106	1139	430	400	2385	4376	2907	2417
86	2BR0201	02	0362	1028	470	423	2617	3936	3083	2278
86	2CR0201	02	1008	1036	470	432	2673	13200	3173	4489
86	25N0201	05	0182	0209	320	298	1746	1500	2466	1917
86	25N0202	05	0182	0222	320	245	1454	1875	2023	2184
86	25N0203	05	0188	0226	320	250	1447	2089	2039	2230
86	25N0204	05	0189	0233	320	303	1856	1766	2485	2016
86	25N0206	05	0191	0229	320	237	1415	1639	1932	2104
86	25N0205	05	0191	0230	320	305	1857	3456	2507	2564
86	25N0207	05	0191	0230	320	326	1926	2242	2683	2102
86	25N0208	05	0194	0236	320	238	1449	3859	1926	3039
86	25N0209	05	0197	0233	320	324	1957	3181	2674	2411
86	25N0210	05	0197	0245	320	370	2229	1341	3040	1786
86	25N0212	05	0198	0238	320	250	1522	1991	2060	2229
86	25N0211	05	0198	0245	320	335	2022	3466	2776	2467
86	25N0213	05	0203	0245	320	330	1935	2565	2705	2183
86	25N0214	05	0204	0244	320	330	1965	1440	2724	1857
86	25N0215	05	0205	0245	320	328	2005	1123	2696	1776
86	25N0216	05	0210	0253	320	351	2116	1289	2873	1789
86	25N0218	05	0252	0280	320	420	2391	1203	3271	1635
86	25N0219	05	0254	0280	320	312	1789	1203	2450	1744
86	25N0220	05	0258	0281	320	268	1531	1203	2054	1787
86	25N0221	05	0259	0287	320	288	1639	1203	2181	1744
86	25N0222	05	0260	0288	320	351	2078	1203	2698	1703
86	25N0223	05	0260	0294	320	393	2314	1206	2976	1653
86	25N0224	05	0261	0292	320	287	1663	1203	2190	1762
86	25N0225	05	0261	0295	320	306	1786	1203	2310	1732
86	25N0226	05	0266	0295	320	297	1708	1203	2221	1728
86	25N0227	05	0267	0294	320	284	1643	1203	1110	1745
86	25N0228	05	0268	0300	320	369	2189	1203	2716	1660
86	25N0229	05	0271	0295	320	229	1379	1203	1675	1859
86	25N0230	05	0272	0307	320	307	1810	1203	2229	1707
86	25N0231	05	0273	0300	320	281	1671	1203	2042	1749
86	26N0201	05	0274	0300	320	271	1580	3506	1996	2602

86	26N0202	05	0274	0307	320	225	1339	2388	1621	2377
86	26N0203	05	0275	0303	320	242	1425	2388	1744	2296
86	26N0204	05	0275	0306	320	218	1289	2388	1570	2407
86	26N0205	05	0286	0313	320	258	1554	2388	1853	2246
86	26N0206	05	0287	0310	320	245	1442	2388	1750	1794
86	26N0207	05	0294	0320	320	311	1874	4957	2251	2920
86	26N0208	05	0295	0322	320	315	1907	2388	2291	2091
86	26N0209	05	0296	0323	320	285	1678	2388	2067	2152
86	26N0210	05	0299	0344	320	320	1942	2388	2328	2081
86	26N0211	05	0300	0328	320	208	1268	2388	1492	2475
86	26N0212	05	0301	0334	320	283	1705	2388	2028	2163
86	26N0213	05	0303	0337	320	240	1454	2388	1731	2322
86	26N0214	05	0306	0344	320	299	1886	2388	2175	2157
86	26N0215	05	0307	0344	320	294	1776	2388	2174	2154
86	26N0216	05	0309	0346	320	299	1830	2388	2205	2148
86	26N0217	05	0313	0346	320	247	1439	2388	1812	2283
86	26N0218	05	0316	0350	320	288	1817	3988	2136	2757
86	26N0219	05	0317	0346	320	286	1820	2388	2125	2214
86	26N0220	05	0322	1004	320	277	1766	5210	2073	3267
86	26N0221	05	0324	1004	320	288	1789	2641	2137	2280
86	26N0222	05	0328	1004	320	271	1640	2641	1969	2306
86	26N0223	05	0329	1004	320	279	1684	2641	2091	2300
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86	26N0225	05	0336	1007	320	271	1668	5210	2008	3279
86	26N0226	05	0337	1013	320	410	2477	2641	3047	1991
86	26N0227	05	0342	1014	320	305	1846	2641	2270	2215
86	26N0228	05	0343	1013	320	324	1948	2641	2401	2157
86	26N0229	05	0344	1014	320	324	1968	2641	2382	2158
86	26N0230	05	0345	1018	320	323	1969	2641	2373	2162
86	26N0231	05	0346	1018	320	347	2116	2641	2546	2105
86	26N0232	05	0350	1021	320	329	2024	2641	2390	2144
86	26N0233	05	0353	1022	320	321	1985	3131	2330	2320
86	26N0234	05	0357	1027	320	288	1783	3131	2083	2430
86	26N0235	05	0364	1029	320	315	1943	3333	2287	2401
86	27N0201	05	1004	1034	320	284	1740	2717	2054	2293
86	27N0202	05	1006	1034	320	296	1828	2717	2144	2260
86	27N0203	05	1008	1043	320	313	1933	2717	2279	2214
86	27N0205	05	1011	1039	320	287	1764	2747	2084	2298
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86	27N0206	05	1012	1049	320	303	1893	2717	2191	2245
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86	27N0208	05	1014	1060	320	331	1991	2717	2408	2150
86	27N0209	05	1015	1049	320	311	1911	2796	2264	2241
86	27N0210	05	1015	1049	320	268	1633	2744	1944	2359
86	27N0211	05	1019	1054	320	282	1746	2717	2095	2356
86	27N0212	05	1020	1049	320	286	1757	2717	2055	2283
86	27N0213	05	1021	1050	320	253	1566	2718	1838	2420
86	27N0214	05	1028	1050	320	305	1911	2717	2242	2252

86	27N0215	05	1029	1056	320	248	1541	2717	1808	2446
86	27N0216	05	1032	1060	320	263	1568	2721	1911	2357
86	27N0217	05	1033	1060	320	289	1788	2717	2118	2292
86	27N0219	05	1034	1061	320	253	1582	2971	1857	2534
86	27N0218	05	1034	1064	320	317	2024	2717	2398	2252
86	27N0220	05	1035	1057	320	248	1552	2718	1824	2457
86	27N0221	05	1035	1061	320	307	1914	2717	2278	2250
86	27N0222	05	1036	1061	320	286	1800	2717	2179	2341
86	27N0223	05	1036	1070	320	253	1593	2717	1906	2457
86	27N0225	05	1042	1064	320	213	1729	2812	2094	2430
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86	27N0226	05	1043	1067	320	291	1802	2717	2208	2312
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86	27N0330	05	1047	1074	320	214	1324	2718	1693	2680
86	27N0331	05	1050	1091	280	282	1744	2473	2211	2279
86	27N0332	05	1057	1091	280	311	1890	2473	2556	2225
86	27N0333	05	1057	1091	280	307	1860	2707	2525	2310
86	27N0334	05	1061	1098	280	310	1930	2473	2578	2252
86	27N0335	05	1063	1091	280	283	1715	2729	2292	2380
86	27N0336	05	1063	1091	280	279	1664	2473	2275	2298
86	27N0337	05	1064	1091	280	287	1737	2473	2317	2274
86	27N0339	05	1067	1091	280	311	1879	2473	2530	2213
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86	27N0343	05	1074	1095	280	278	1670	2473	2192	2279
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86	27N0346	05	1084	1099	280	242	1454	2473	1798	2366
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86	28N0703	05	1096	1118	280	260	1561	4166	1883	2927
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86	28N0705	05	1099	1124	280	244	1440	4166	1770	3023
86	28N0706	05	1103	1135	280	251	1495	4166	1818	2980
86	28N0707	05	1104	1127	280	271	1637	4166	1948	2860
86	28N0708	05	1106	1127	280	215	1288	4166	1553	3259
86	28N0709	05	1110	1132	280	233	1382	4166	1664	3095
86	28N0710	05	1112	1135	280	236	1409	4166	1698	3082
86	28N0711	05	1113	1141	280	222	1342	4166	1590	3197
86	28N0712	05	1117	1139	280	230	1370	4166	1646	3123
86	28N0713	05	1119	1145	280	250	1532	4166	1824	3009
86	28N0714	05	1124	1141	280	257	1541	4166	1821	2929

86	28N0716	05	1125	1154	280	279	1658	5627	1927	3302
86	28N0715	05	1125	1155	280	292	1764	4166	1990	2712
86	28N0717	05	1127	1175	280	419	2575	4166	2799	2277
86	28N0718	05	1131	1161	280	290	1745	4166	1928	2703
86	28N0719	05	1132	1156	280	279	1678	4202	1844	2768
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86	28N0721	05	1134	1161	280	207	1272	4166	1387	3297
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86	28N0723	05	1135	1166	280	239	1463	4166	1559	3008
86	28N0724	05	1138	1166	280	236	1436	4166	1499	3009
86	28N0725	05	1138	1166	280	187	1146	4166	1187	3475
86	28N0726	05	1139	1168	280	295	1821	4166	1885	2668
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86	28N0732	05	1147	1182	280	319	1912	4166	2010	2543
86	28N0733	05	1149	1175	280	238	1572	4166	1554	3064
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86	28N0736	05	1155	1183	280	304	1826	3000	1910	2216
86	28N0737	05	1159	1196	280	341	2087	2666	2261	2057
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89	24P0106	01	0155	0202	400	526	3038	10810	3853	3365
89	24P0107	01	0166	0208	500	383	2198	13753	2831	4904
89	24P0108	01	0176	0212	500	431	2494	12026	3475	4175
89	24P0109	01	0177	0223	500	507	2977	14474	4149	4260
89	21P0101	01	0183	0226	500	444	2556	6937	3605	2950
89	21P0102	01	0201	0243	500	456	2579	6202	3631	2722
89	21P0103	01	0215	0246	500	432	2507	4300	3463	2377
89	21P0104	01	0216	0261	500	496	2885	4266	4036	2255
89	21P0105	01	0226	0264	500	441	2624	4246	3607	2376
89	21P0106	01	0243	0271	500	513	2897	4323	4083	2203
89	21P0107	01	0252	0281	500	537	3051	4029	4198	2100
89	21P0108	01	0258	0296	500	354	2068	4052	2693	2490
89	21P0109	01	0267	0306	500	505	2974	3878	3778	2105
89	22P0101	01	0281	0313	500	452	2630	6237	3283	2688
89	22P0102	01	0285	0322	500	425	2500	6164	3094	2767
89	22P0103	01	0295	0334	500	397	2457	6164	3021	2932
89	22P0104	01	0300	0339	500	412	2414	6164	2984	2806
89	22P0105	01	0301	0346	500	464	2772	6164	3420	2663
89	22P0106	01	0342	1011	440	456	2781	6719	3352	2818
89	22P0107	01	0349	1014	440	475	2955	6719	3500	2773
89	23P0101	01	1004	1034	440	464	2848	7135	3376	2879
89	23P0102	01	1011	1050	440	455	2825	7173	3299	2922
89	23P0103	01	1032	1060	440	409	2465	7308	2991	3121
89	23P0104	01	1055	1091	440	429	2604	7667	3449	3198

89	23P0105	01	1062	1091	440	365	2202	7212	2954	3388
89	24P0101	01	1095	1123	440	351	2096	8076	2556	3626
89	24P0102	01	1124	1155	440	416	2586	8148	2860	3268
89	24P0103	01	1154	1182	440	408	2544	8076	2570	3233
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89	24P0105	01	1175	1208	440	389	2333	12050	2936	4452
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89	25P0304	03	0195	0216	150	172	1014	1177	1368	2069
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89	25P0308	03	0203	0223	150	107	651	1188	859	2521
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89	25P0311	03	0209	0238	150	218	1275	1197	1764	1943
89	25P0313	03	0215	0236	150	136	844	1177	1087	2143
89	25P0312	03	0215	0239	150	189	1160	1177	1532	2047
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89	25P0315	03	0222	0238	150	152	896	1177	1221	2167
89	25P0318	03	0224	0240	150	38	236	1177	276	4445
89	25P0317	03	0224	0247	150	139	816	1177	1128	2245
89	25P0321	03	0224	0254	190	306	1786	1493	2488	1885
89	25P0319	03	0226	0236	150	225	1336	1177	1844	1936
89	25P0320	03	0226	0244	150	131	797	1422	1071	2511
89	25P0322	03	0226	0254	190	188	1127	1493	1512	2198
89	25P0325	03	0237	0267	190	268	1599	1494	2175	1966
89	25P0323	03	0243	0258	150	118	710	1293	961	2512
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89	25P0328	03	0258	0274	150	185	1058	1177	1484	2010
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89	25P0333	03	0266	0285	150	172	984	1177	1288	2005
89	26P0301	03	0279	0289	150	197	1154	1452	1384	2025
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89	26P0322	03	0309	0323	150	122	736	1451	861	2498
89	26P0321	03	0309	0328	150	182	1061	1451	1299	2094
89	26P0323	03	0313	0334	150	137	831	1451	968	2372
89	26P0324	03	0313	0339	150	165	977	1451	1206	2202
89	26P0326	03	0313	0339	150	206	1261	1451	1500	2045

89	26P0325	03	0316	0329	150	142	822	1451	1009	2311
89	26P0329	03	0339	0351	150	150	942	1485	1121	2365
89	26P0330	03	0339	0351	150	218	1408	1451	1615	2052
89	26P0337	03	0358	1019	160	252	1537	1893	1815	2081
89	27P0303	03	1008	1027	160	190	1177	1689	1351	2219
89	27P0302	03	1008	1028	160	209	1250	1700	1498	2128
89	27P0308	03	1019	1039	160	207	1255	1356	1491	1982
89	27P0311	03	1026	1040	160	126	757	1356	879	2375
89	27P0310	03	1026	1041	160	148	921	1425	1027	2279
89	27P0317	03	1040	1054	160	101	632	1356	719	2680
89	27P0316	03	1040	1055	160	158	1034	1356	1138	2233
89	27P0318	03	1042	1063	160	186	1164	1356	1381	2097
89	27P0320	03	1055	1071	160	210	1321	1356	1721	2094
89	27P0321	03	1055	1071	160	122	748	1356	990	2536
89	28P0301	03	1098	1116	160	245	1483	2518	1740	2343
89	28P0302	03	1098	1116	160	252	1550	2585	1820	2363
89	28P0303	03	1103	1116	160	168	994	2518	1214	2813
89	28P0304	03	1103	1117	160	158	926	2518	1140	2901
89	28P0305	03	1110	1124	160	219	1297	2518	1585	2466
89	28P0306	03	1110	1124	160	165	971	2518	1178	2828
89	28P0307	03	1117	1127	160	114	969	2518	800	3521
89	28P0308	03	1117	1133	160	228	1389	2555	1629	2444
89	28P0309	03	1119	1140	160	208	1258	2996	1453	2744
89	28P0314	03	1134	1147	160	152	929	4258	1035	4093
89	28P0313	03	1134	1148	160	141	867	2293	957	2920
89	28P0316	03	1142	1156	160	154	961	2018	650	2551
89	28P0317	03	1149	1163	160	144	874	2018	872	2614
89	28P0319	03	1162	1172	160	124	801	2018	788	2909
89	28P0320	03	1162	1172	160	105	687	2018	651	3196
89	28P0322	03	1175	1194	160	233	1368	3579	1681	2845
89	28P0321	03	1175	1210	160	314	1883	839	2294	1597
89	28P0323	03	1181	1206	160	185	1089	1339	1428	2084
89	28P0324	03	1184	1231	160	265	1594	1340	2106	1902
89	28P0331	04	0166	0182	190	149	863	1253	1004	2094
89	28P0330	04	0166	0183	190	190	1113	1110	1280	1844
89	28P0332	04	0168	0189	190	214	1215	2923	1506	2637
89	28P0333	04	0168	0190	190	174	1001	2200	1258	2563
89	28P0336	04	0169	0196	190	228	1322	2025	1667	2199
89	28P0337	04	0177	0196	190	136	751	735	1108	1907
89	28P0340	04	0180	0209	190	141	841	840	1070	1951
89	28P0339	04	0180	0210	190	147	866	845	1137	1937
89	28P0341	04	0181	0212	190	314	1834	2637	2538	2232
89	28P0342	04	0181	0212	190	233	1345	1582	1890	2067
89	25P0301	04	0189	0218	190	139	839	1584	1107	2540
89	25P0303	04	0190	0229	190	175	1065	1496	1340	2229
89	25P0302	04	0190	0233	190	282	1726	2816	2293	2424
89	25P0316	04	0224	0254	190	142	1776	1494	2407	3998
89	25P0330	04	0251	0274	190	158	883	1494	1243	2291

89	25P0331	04	0251	0275	190	188	1051	1493	1495	2148
89	25P0334	04	0271	0300	190	165	941	1805	1181	2380
89	25P0335	04	0273	0306	190	175	1103	1822	1259	2391
89	26P0303	04	0282	0310	190	315	1844	1967	2272	1931
89	26P0311	04	0293	0320	190	297	1733	1835	2088	1904
89	26P0312	04	0303	0329	190	286	1645	1835	2050	1934
89	26P0317	04	0303	0337	190	199	1193	1835	1404	2227
89	26P0318	04	0306	0343	190	279	1658	1835	2038	1982
89	26P0320	04	0309	0346	190	210	1238	1835	1500	2178
89	26P0319	04	0319	0345	190	225	1349	1835	1605	2128
89	26P0327	04	0322	0349	190	139	868	1835	1031	2686
89	26P0328	04	0323	0345	190	202	1282	1835	1444	2258
89	26P0331	04	0327	0346	190	188	1187	1835	1389	2346
89	26P0332	04	0339	1004	210	269	1669	2568	1967	2417
89	26P0333	04	0339	1007	210	303	1902	2568	2247	2217
89	26P0334	04	0344	1018	210	380	2272	2915	2805	2103
89	26P0335	04	0349	1022	210	353	2063	2842	2589	2123
89	26P0336	04	0352	1018	210	249	1484	2832	1791	2453
89	26P0339	04	0362	1027	210	322	1958	2023	2311	1954
89	27P0301	04	1005	1032	210	280	1687	1783	2002	1954
89	27P0304	04	1013	1036	210	259	1705	1852	1866	2094
89	27P0305	04	1014	1032	210	244	1489	1782	1747	2057
89	27P0306	04	1015	1039	210	233	1442	1782	1660	2096
89	27P0307	04	1019	1036	210	185	1134	1782	1325	2292
89	27P0309	04	1022	1050	210	173	1076	1782	1224	2360
89	27P0312	04	1026	1050	210	240	1535	2129	1705	2237
89	27P0313	04	1027	1061	210	264	1650	2242	1883	2188
89	27P0315	04	1034	1053	210	212	1353	1809	1521	2209
89	27P0314	04	1034	1057	210	314	1975	1782	2276	1921
89	27P0319	04	1042	1056	210	167	1037	1782	1209	2412
89	27P0322	04	1053	1076	210	240	1492	1782	1904	2158
89	27P0323	04	1056	1077	210	218	1369	1782	1773	2259
89	27P0324	04	1056	1077	210	242	1529	2026	2020	2304
89	27P0325	04	1060	1091	210	291	1770	3156	2341	2497
89	27P0326	04	1060	1091	210	247	1485	3164	1999	2691
89	27P0327	04	1070	1097	210	249	1505	3142	1991	2666
89	27P0330	04	1081	1092	210	93	566	3142	720	4761
89	27P0331	04	1089	1104	210	157	954	3318	1133	3443
91	25J0311	03	0223	0251	310	231	1441	2627	1888	2578
91	25J0312	03	0223	0251	310	325	1978	2627	2654	2234
91	25J0313	03	0226	0251	310	434	2584	2627	3540	2016
91	25J0314	03	0226	0254	310	201	1163	2627	1624	2694
91	25J0315	03	0231	0245	310	174	1033	2627	1424	2922
91	25J0317	03	0232	0258	310	208	1306	2627	1822	2767
91	25J0320	03	0233	0259	310	306	1797	2627	2515	2268
91	25J0319	03	0233	0260	310	235	1441	2627	1927	2551
91	25J0322	03	0237	0260	310	264	1595	2627	2121	2403
91	25J0321	03	0237	0261	310	269	1659	2627	2175	2402

91	25J0325	03	0239	0261	310	347	2102	2627	2821	2176
91	25J0321	03	0243	0265	310	196	1172	2843	1598	2864
91	25J0327	03	0243	0267	310	330	1887	2627	2636	2167
91	25J0336	03	0253	0282	310	398	2286	2627	3138	2023
91	26J0342	03	0258	0294	310	672	3907	2828	5033	1751
91	25J0343	03	0265	0289	310	221	1264	2828	1671	2608
91	25J0344	03	0265	0292	310	231	1352	2828	1681	2537
91	25J0351	03	0267	0286	310	173	979	2828	1281	2941
91	26J0302	03	0274	0294	310	121	731	1412	836	2462
91	26J0301	03	0274	0299	310	488	2904	1411	3592	1620
91	26J0304	03	0275	0293	310	259	1529	1412	1883	1863
91	26J0305	03	0275	0293	310	147	858	1411	1048	2256
91	26J0306	03	0279	0301	310	232	1365	1412	1183	1922
91	26J0307	03	0279	0303	310	289	1676	1411	2121	1802
91	26J0308	03	0281	0303	310	288	1712	1411	2101	1814
91	26J0309	03	0281	0306	310	259	1524	1412	1884	1861
91	26J0311	03	0282	0310	310	363	2182	1411	2630	1714
91	26J0312	03	0282	0310	310	337	1966	1411	2470	1735
91	26J0314	03	0286	0313	310	206	1209	1411	1506	2003
91	26J0316	03	0288	0320	310	436	2632	1411	3209	1663
91	26J0315	03	0288	0323	310	432	2547	1411	3150	1645
91	26J0318	03	0289	0322	310	299	1758	1411	2179	1789
91	26J0317	03	0289	0324	310	462	2776	1411	3358	1633
91	26J0322	03	0296	0314	310	311	1844	1411	2237	1766
91	26J0323	03	0296	0314	310	188	1113	1411	1354	2063
91	26J0324	03	0302	0324	310	380	2314	1412	2805	1719
91	26J0328	03	0310	0345	310	194	951	1344	1187	1795
91	26J0337	03	0313	0344	310	219	1351	1411	1622	2002
91	26J0327	03	0314	0345	310	409	2418	1411	3018	1674
91	26J0326	03	0314	0349	310	416	2640	1411	3253	1756
91	26J0341	03	0322	0349	310	293	1894	1411	2314	1919
91	26J0349	03	0327	0350	310	395	2470	1411	3106	1769
91	26J0350	03	0327	0356	310	287	1897	1411	2314	1959
91	26J0352	03	0329	0356	310	367	2678	1411	3255	2001
91	26J0353	03	0337	1004	280	575	3541	1516	4335	1633
91	26J0355	03	0338	0358	310	246	1691	1516	1967	2103
91	26J0356	03	0338	1004	280	290	1851	1516	2158	1905
91	26J0361	03	0343	1006	280	476	3016	1397	3559	1675
91	26J0351	03	0351	0357	310	608	3898	1411	4934	1685
91	26J0374	03	0352	1018	280	342	2133	1890	2522	1914
91	26J0375	03	0352	1026	280	382	2317	1889	2820	1839
91	26J0377	03	0355	1029	280	316	1941	1889	2322	1947
91	26J0376	03	0356	1022	280	251	1551	1889	1838	2103
91	26J0385	03	0363	1029	280	274	1715	1889	1972	2035
91	26J0386	03	0365	1029	280	249	1560	1889	1790	2104
91	26J0387	03	0365	1034	280	204	1247	1890	1461	2254
91	27J0302	03	1004	1033	280	280	1779	2753	2018	2339
91	27J0304	03	1006	1035	280	286	1764	1546	2098	1891

91	27J0313	03	1013	1042	280	395	2372	1587	2847	1723
91	27J0316	03	1021	1053	280	360	2224	1546	2688	1794
91	27J0315	03	1021	1057	280	352	2320	1546	2626	1844
91	27J0323	03	1033	1054	280	235	1488	1546	1743	2033
91	27J0322	03	1033	1060	280	326	2106	1546	2418	1862
91	27J0324	03	1041	1071	280	331	2039	1546	2587	1865
91	27J0325	03	1041	1082	280	423	2698	1546	3400	1807
91	27J0333	03	1048	1077	280	280	1807	1546	2327	2029
91	27J0332	03	1048	1078	280	371	2419	1546	3145	1916
91	27J0326	03	1050	1082	280	357	2231	1613	2936	1899
91	27J0327	03	1050	1082	280	383	2396	1578	3104	1848
91	27J0335	03	1060	1084	280	341	2373	1546	3116	2063
91	27J0336	03	1063	1091	280	427	2632	2621	3522	2055
91	27J0337	03	1063	1091	280	337	2095	2621	2796	2229
91	27J0339	03	1069	1097	280	317	1953	2621	2550	2247
91	27J0338	03	1069	1104	280	321	1949	2621	2522	2209
91	27J0345	03	1077	1105	280	451	2695	2621	3474	1949
91	27J0346	03	1077	1109	280	307	1815	2621	2401	2227
91	27J0355	03	1088	1119	280	330	1917	2797	2465	2192
91	28J0302	03	1092	1127	280	387	2333	2391	2805	1945
91	28J0303	03	1098	1131	280	336	2041	2185	2424	1979
91	28J0306	03	1099	1127	280	279	1696	2185	1990	2104
91	28J0307	03	1099	1131	280	283	1753	2625	2021	2261
91	28J0309	03	1112	1153	280	365	2248	2185	2583	1922
91	28J0313	03	1117	1155	115	386	2314	2185	2683	1861
91	28J0314	03	1117	1155	115	339	2027	2185	2330	1930
91	28J0315	03	1123	1154	115	277	1657	2185	1866	2061
91	28J0316	03	1123	1156	115	217	1295	2185	1485	2288
91	28J0318	03	1125	1156	115	207	1291	2185	1396	2354
91	28J0317	03	1125	1161	115	301	1920	2185	2053	2046
91	28J0322	03	1133	1163	115	302	1867	2185	2001	2004
91	28J0323	03	1133	1166	115	209	1292	2185	1345	2307
91	28J0331	03	1142	1174	280	180	1278	2185	1252	2619
91	28J0345	03	1160	1175	280	187	1751	2185	1742	3036
91	28J0346	03	1160	1183	300	282	1660	2497	1798	2112
91	28J0341	03	1161	1182	300	315	1897	2497	2075	2054
91	28J0342	03	1161	1187	300	362	2118	2497	2502	1966
91	28J0344	03	1163	1197	300	322	1981	4714	2201	2763
91	28J0343	03	1163	1200	300	406	2437	4722	2830	2460
91	28J0354	03	1167	1202	300	325	1989	4714	2397	2800
91	28J0345	04	0147	0189	390	418	2477	1151	2954	1575
91	28J0356	04	0155	0212	390	846	4891	6619	6220	2096
91	28J0358	04	0156	0182	390	440	2594	6661	2960	2776
91	28J0357	04	0156	0194	390	357	2090	1569	2445	1710
91	28J0359	04	0161	0205	390	654	3845	1954	5030	1656
91	28J0360	04	0162	0197	390	522	3100	4859	3889	2270
91	28J0361	04	0163	0209	390	504	2970	5853	3887	2522
91	28J0362	04	0168	0210	390	838	4905	10664	6629	2649

91	28J0363	04	0169	0212	390	683	3976	5066	5325	2104
91	28J0364	04	0170	0212	390	748	4445	1608	5919	1601
91	28J0365	04	0170	0212	390	500	2961	1243	3919	1625
91	28J0366	04	0174	0223	390	560	3274	2178	4396	1759
91	28J0367	04	0175	0233	390	752	4509	2369	6097	1725
91	28J0368	04	0176	0223	390	696	4187	2561	5635	1779
91	28J0371	04	0176	0223	390	960	5666	2500	7653	1648
91	28J0372	04	0177	0212	390	459	2689	1839	3670	1786
91	25J0301	04	0182	0216	610	402	2391	5287	3266	2722
91	25J0302	04	0194	0230	610	1019	6064	11486	8486	2555
91	25J0303	04	0196	0233	610	642	3828	5772	5244	2312
91	25J0304	04	0198	0233	610	405	2422	5585	3206	2769
91	25J0305	04	0201	0240	610	904	5301	6255	7473	2105
91	25J0306	04	0202	0243	610	738	4368	5247	6092	2128
91	25J0307	04	0203	0243	610	594	3581	5286	4855	2310
91	25J0308	04	0204	0225	610	465	2762	5338	3792	2557
91	25J0309	04	0210	0259	610	834	4951	5247	6922	2053
91	25J0310	04	0211	0253	610	438	2753	5247	3524	2631
91	25J0323	04	0230	0264	610	754	4549	5247	6225	2125
91	25J0330	04	0237	0274	610	476	2908	5247	3789	2509
91	25J0331	04	0238	0274	610	640	3798	5263	5173	2224
91	25J0332	04	0239	0260	610	498	3063	5247	3975	2467
91	25J0337	04	0246	0278	610	749	4351	5247	6042	2088
91	25J0338	04	0247	0280	610	642	3710	5247	5087	2188
91	25J0339	04	0253	0275	610	366	2123	5247	2890	2803
91	25J0340	04	0254	0280	610	365	2097	5247	2856	2795
91	25J0345	04	0254	0286	610	967	5608	5642	7447	1942
91	25J0349	04	0258	0274	610	340	1969	5247	2763	2935
91	25J0346	04	0258	0296	610	885	5078	5642	6828	1983
91	25J0347	04	0259	0303	610	1005	5897	5642	7512	1896
91	25J0348	04	0261	0293	610	511	2935	5642	3833	2429
91	25J0350	04	0268	0299	610	322	1885	5247	2370	2951
91	26J0303	04	0275	0309	610	556	3306	2781	3975	1810
91	26J0310	04	0278	0310	610	752	4347	2781	5462	1674
91	26J0319	04	0287	0342	610	920	5480	2781	6759	1633
91	26J0320	04	0288	0322	610	549	3137	2821	3992	1812
91	26J0321	04	0289	0314	610	427	2502	2781	3041	1949
91	26J0330	04	0301	0336	610	495	2862	2781	3574	1862
91	26J0331	04	0302	0337	610	499	3076	2781	3952	1966
91	26J0379	04	0305	1039	610	1017	6254	3961	7538	1746
91	26J0332	04	0308	0347	610	592	3757	2781	4626	1886
91	26J0333	04	0308	0349	610	672	3991	2941	4979	1772
91	26J0334	04	0309	0353	610	764	4537	2781	5696	1703
91	26J0335	04	0310	0350	610	718	4392	2781	5432	1756
91	26J0343	04	0316	0328	610	126	757	2781	871	3499
91	26J0344	04	0317	0352	610	466	2919	2781	3627	2002
91	26J0345	04	0322	0356	610	606	3880	5638	4690	2345
91	26J0346	04	0323	0353	610	477	3084	2781	3716	2009

91	26J0347	04	0323	0356	610	592	4025	2781	4840	1967
91	26J0348	04	0324	0357	610	529	3254	2781	4147	1925
91	26J0357	04	0329	0357	610	591	3968	2781	4833	1960
91	26J0358	04	0329	0358	610	641	4309	2885	5211	1935
91	26J0363	04	0336	1004	610	691	4086	2885	5227	1765
91	26J0354	04	0337	1007	610	725	4476	2885	5427	1764
91	26J0336	04	0337	1011	610	515	3093	2885	3827	1904
91	26J0365	04	0338	1014	610	828	5050	2886	6168	1703
91	26J0366	04	0339	1007	610	354	2182	2885	2575	2159
91	26J0367	04	0342	1019	610	788	4860	3961	5726	1846
91	26J0368	04	0343	1008	610	568	3463	2885	4141	1847
91	26J0369	04	0344	1011	610	598	3681	105	4274	1348
91	26J0370	04	0345	1019	610	788	4818	4073	5797	1864
91	26J0371	04	0346	1018	610	502	3080	3961	3665	2133
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91	26J0380	04	0352	1039	610	540	3341	3961	3938	2081
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91	26J0382	04	0357	1027	610	887	5492	3961	6497	1798
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91	26J0388	04	0363	1029	610	672	4168	3961	4826	1928
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91	27J0317	04	1012	1043	610	492	3067	3418	3560	2042
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91	27J0331	04	1042	1081	610	665	4431	3370	5528	2004
91	27J0329	04	1055	1113	550	486	2956	2777	3939	1990
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91	27J0341	04	1056	1084	610	478	3039	3370	4067	2192
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91	27J0352	04	1078	1112	550	669	4049	5129	5004	2120

91	27J0347	04	1083	1112	550	402	2412	2621	3056	2012
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91	27J0356	04	1089	1119	550	391	2369	5238	2755	2650
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91	28J0311	04	1113	1145	550	388	2396	4370	2753	2453
91	28J0312	04	1119	1167	550	624	3925	4370	4238	2008
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91	28J0332	04	1140	1167	550	564	3638	4370	3592	2057
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91	28J0338	04	1146	1202	600	1159	7284	4370	7880	1685
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91	28J0358	04	1173	1203	600	434	2629	7024	3078	2933
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92	22J0132	01	0356	1036	01340	01485	009141	013887	011039	02294
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92	22J0135	01	0364	1034	01340	01107	006849	013869	008156	02608
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92	23J0120	01	1042	1078	01340	01264	008072	014192	010554	02596
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92	23J0122	01	1048	1078	01340	01295	008386	014292	011228	02618
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93	2EU0301	04	0334	0357	610	395	3238	1107	3857	2076
93	2EU0302	04	0334	0358	610	376	2473	1386	2961	1814
93	2EU0303	04	1099	1131	550	373	2224	427	2678	1427
93	2EU0304	04	1106	1139	550	482	2945	0	3442	1325
95	24K0111	01	0146	0182	01260	01368	007905	005964	009577	01714
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95	24K0118	01	0181	0233	01260	01234	007295	012244	010258	02415
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95	21K0106	01	0208	0252	01260	01040	006199	013561	008677	02734
95	21K0107	01	0209	0246	01260	01032	006100	013483	008626	02733
95	21K0108	01	0215	0253	01260	01136	006766	009042	009479	02226
95	21K0109	01	0216	0253	01260	01174	007003	009043	009772	02199
95	21K0110	01	0222	0274	01260	01041	006746	009043	009429	02422
95	21K0111	01	0229	0266	01260	01041	006184	009043	008608	02290
95	21K0112	01	0238	0271	01260	01075	006277	008681	008871	02217
95	21K0113	01	0239	0274	01260	01161	006772	008681	009611	02159
95	21K0114	01	0240	0285	01210	01291	007507	012001	010654	02336
95	21K0115	01	0245	0346	01210	01158	006761	011931	009321	02419
95	21K0116	01	0246	0286	01210	01120	006519	012010	009021	02460
95	21K0117	01	0253	0322	01210	01450	008476	011931	011379	02192
95	21K0118	01	0254	0289	01210	01212	006950	011931	009601	02350
95	21K0119	01	0257	0299	01210	01301	007468	011931	010134	02270
95	21K0120	01	0258	0303	01210	00992	005758	011931	007699	02559
95	21K0121	01	0259	0303	01210	01094	006332	011931	008434	02440
95	22K0101	01	0292	0327	01210	01024	005882	007988	007532	02090
95	22K0102	01	0294	0328	01210	01242	007089	007988	009173	01952
95	22K0103	01	0295	0334	01210	01167	006636	007988	008577	01988
95	22K0104	01	0296	0338	01210	01213	006960	008074	008978	01980
95	22K0105	01	0299	0349	01210	01185	006772	008029	008783	01990
95	22K0106	01	0300	0338	01210	01280	007415	007988	009499	01945
95	22K0107	01	0301	0344	01210	01228	007209	007988	009051	01975
95	22K0108	01	0306	0343	01210	01184	006973	007988	008793	02006
95	22K0109	01	0307	0346	01210	01017	005957	007988	007568	02115
95	22K0110	01	0320	0353	01210	01223	007383	007988	009233	02012
95	22K0111	01	0327	1008	01200	01437	008661	012982	010976	02270
95	22K0112	01	0328	1006	01200	01132	006727	012982	008626	02503
95	22K0113	01	0337	1025	01200	01457	008721	012982	011086	02250
95	22K0114	01	0339	1011	01200	01300	007751	012982	009854	02353
95	23K0101	01	1008	1048	01200	01303	008034	011555	009596	02240
95	23K0102	01	1011	1054	01200	01336	008181	011528	009924	02218
95	23K0103	01	1011	1055	01200	01232	007667	011482	009129	02295
95	23K0104	01	1012	1054	01200	01178	007276	012531	008704	02420
95	23K0105	01	1018	1056	01200	01196	007367	011862	008856	02348
95	23K0106	01	1019	1061	01200	01247	007743	011483	009562	02284
95	23K0107	01	1026	1064	01200	01421	008782	011483	010780	02185
95	23K0108	01	1028	1076	01200	01335	008227	014599	010091	02466

95	23K0109	01	1029	1071	01200	01193	007376	011483	009115	02345
95	23K0110	01	1032	1070	01200	01304	008025	011483	009957	02260
95	23K0111	01	1034	1071	01200	01374	008657	011502	010927	02262
95	23K0112	01	1039	1078	01200	01174	007396	011483	009443	02412
95	23K0113	01	1041	1078	01200	01317	008132	011483	010614	02295
95	23K0114	01	1050	1091	01230	01108	006804	011777	009019	02491
95	23K0115	01	1060	1095	01230	01313	007935	011777	011065	02344
95	23K0116	01	1067	1103	01230	01225	007351	012702	010141	02465
95	23K0117	01	1068	1103	01230	01254	007568	012737	010287	02439
95	23K0118	01	1069	1105	01230	01118	006672	012702	009133	02550
95	23K0119	01	1074	1110	01230	01288	007718	012703	010261	02382
95	23K0120	01	1076	1118	01230	01269	007577	013582	009896	02447
95	23K0121	01	1077	1112	01230	01319	007899	012707	010222	02337
95	23K0122	01	1081	1116	01230	01089	006498	012702	008328	02528
95	23K0123	01	1082	1132	01230	01349	008017	012702	010241	02295
95	23K0124	01	1084	1123	01230	01218	007287	014022	009142	02500
95	23K0125	01	1089	1132	01230	01374	008263	012703	010261	02273
95	23K0126	01	1089	1139	01230	01144	006794	012703	008504	02448
95	23K0127	01	1089	1142	01230	01107	006590	012892	008773	02503
95	23K0128	01	1090	1126	01230	01182	007058	012702	008763	02413
95	24K0101	01	1091	1125	01230	01304	007777	010858	009644	02167
95	24K0102	01	1095	1131	01230	01180	007014	010857	008680	02250
95	24K0103	01	1095	1140	01230	01117	006608	010857	008240	02301
95	24K0104	01	1096	1127	01230	01230	007407	010857	009080	02223
95	24K0105	01	1097	1134	01230	01115	006599	010857	008208	02302
95	24K0106	01	1098	1138	01230	01106	006671	010857	008162	02323
95	24K0107	01	1102	1139	01230	01172	006952	010857	008647	02257
95	24K0108	01	1103	1145	01230	01190	007161	012177	008742	02360
95	24K0109	01	1104	1162	01230	01368	008234	010857	009856	02116
95	24K0110	01	1105	1142	01230	01152	007091	010857	008393	02287
95	24K0111	01	1106	1146	01230	01161	007140	010885	008492	02284
95	24K0112	01	1109	1146	01230	01213	007420	011142	008831	02258
95	24K0113	01	1110	1148	01230	01177	007258	010857	008552	02266
95	24K0114	01	1111	1149	01230	01185	007318	010875	008596	02261
95	24K0115	01	1112	1155	01230	01174	007246	010857	008440	02261
95	24K0116	01	1113	1154	01230	01092	006776	010859	007762	02326
95	24K0117	01	1116	1156	01230	01207	007378	011297	008494	02251
95	24K0119	01	1116	1160	01230	01178	007235	010857	008084	02222
95	24K0118	01	1117	1159	01230	01138	007107	010857	008026	02284
95	24K0120	01	1119	1167	01230	01209	007515	012178	008358	02320
95	24K0121	01	1120	1161	01230	01230	007553	010876	008483	02188
95	24K0123	01	1124	1163	01230	01232	007639	010876	008544	02196
95	24K0122	01	1124	1169	01230	01403	008776	010857	009607	02084
95	24K0124	01	1125	1168	01230	01270	007937	011298	008689	02199
95	24K0125	01	1126	1163	01230	01077	006757	010886	007364	02322
95	24K0126	01	1127	1166	01230	01184	007451	010876	007918	02217
95	24K0127	01	1131	1167	01230	01210	007803	010857	008458	02241
95	24K0128	01	1131	1168	01230	01203	007597	011316	008131	02248

95	24K0129	01	1132	1166	01230	01159	007328	010858	007729	02236
95	24K0130	01	1133	1169	01230	01161	007280	011297	007683	02262
95	24K0131	01	1134	1174	01230	01244	007891	010857	008177	02164
95	24K0132	01	1135	1173	01230	01110	006960	010857	007190	02253
95	24K0133	01	1138	1175	01230	01195	007715	010875	007945	02221
95	24K0134	01	1139	1183	01280	01352	008360	010857	008601	02058
95	24K0135	01	1140	1175	01230	01116	007315	010857	007408	02292
95	24K0136	01	1141	1175	01230	01152	007372	010857	007553	02238
95	24K0137	01	1145	1183	01280	01319	008224	010857	008305	02076
95	24K0138	01	1147	1204	1280	1448	9003	14659	9554	2294
95	24K0139	01	1153	1196	01280	01384	008508	015094	009029	02358
95	24K0140	01	1154	1187	01280	01188	007245	015113	007587	02521
95	24K0141	01	1155	1190	01280	01266	007628	015112	008165	02441
95	24K0142	01	1156	1193	01280	01246	007480	016069	008141	02543
95	24K0143	01	1159	1197	01280	01091	006618	015094	007459	02674
95	24K0144	01	1160	1196	01280	01257	007540	015714	008596	02486
95	24K0145	01	1161	1200	1280	1263	7632	15113	8665	2487
95	24K0146	01	1162	1209	1280	1419	8499	15109	9961	2366
95	24K0147	01	1166	1202	1280	1268	7680	15153	9127	2521
95	24K0149	01	1167	1207	1280	1251	7446	15094	9114	2530
95	24K0151	01	1169	1208	1280	1273	7638	15114	9531	2536
95	24K0152	01	1172	1211	1280	1114	6737	15113	8524	2727
95	24K0153	01	1173	1214	1280	1245	7472	15113	9652	2589
95	24K0154	01	1174	1215	1280	1108	6741	15113	8694	2757
95	24K0155	01	1175	1216	1280	1200	7354	15094	9465	2659
95	24K0156	01	1176	1217	1280	1086	6608	15629	9584	2930
95	24K0157	01	1179	1216	1280	1296	8000	15094	10495	2592
95	24K0158	01	1180	1216	1280	1225	7458	21842	9924	3202
95	24K0159	01	1181	1217	1280	1298	7988	21842	10502	3107
95	25K0302	03	0188	0212	320	227	1267	1713	1886	2144
95	25K0301	03	0188	0225	320	645	3862	2571	5313	1821
95	25K0304	03	0191	0205	320	128	0759	1620	1022	2657
95	25K0306	03	0191	0205	320	156	987	1620	1245	2469
95	25K0303	03	0191	0211	320	211	1227	1620	1738	2173
95	25K0305	03	0191	0225	320	407	2473	1784	3354	1870
95	25K0307	03	0195	0209	320	146	867	1620	1174	2508
95	25K0312	03	0201	0218	320	186	1107	2065	1545	2536
95	25K0311	03	0201	0226	320	313	1867	1620	2600	1945
95	25K0313	03	0203	0226	320	326	1928	1730	2660	1938
95	25K0314	03	0203	0229	320	362	2089	1620	1310	1856
95	25K0315	03	0205	0225	320	121	0699	1620	987	2732
95	25K0316	03	0205	0229	320	232	1366	1649	1922	2128
95	25K0319	03	0211	0232	320	158	939	1620	1287	2434
95	25K0320	03	0211	0240	320	281	1687	1620	2343	2011
95	25K0322	03	0215	0240	320	282	1683	1620	2334	1999
95	25K0328	03	0218	0246	320	278	1668	1620	2279	2003
95	25K0327	03	0218	0253	320	334	1973	1620	2765	1904
95	25K0329	03	0222	0251	320	459	2784	1620	3764	1779

95	25K0330	03	0222	0253	320	241	1470	1649	1979	2115
95	25K0331	03	0225	0254	320	324	1927	1620	2660	1916
95	25K0336	03	0229	0259	320	261	1639	1620	2138	2068
95	25K0339	03	0244	0265	320	333	2146	1620	2690	1937
95	25K0343	03	0246	0265	320	297	1779	1620	2401	1953
95	25K0344	03	0246	0267	320	285	1695	1620	2341	1985
95	25K0346	03	0254	0281	320	406	2348	1620	3115	1745
95	26K0307	03	0295	0310	320	352	2144	2431	2546	2023
95	26K0308	03	0295	0316	320	330	1971	2431	2375	2054
95	26K0310	03	0300	0336	320	525	3095	2432	3833	1783
95	26K0314	03	0303	0327	320	380	2202	2432	2732	1938
95	26K0315	03	0303	0329	320	332	1951	2431	2415	2047
95	26K0319	03	0307	0339	320	377	2243	2431	2740	1967
95	26K0317	03	0308	0337	320	408	2416	2716	2968	1985
95	26K0316	03	0308	0342	320	475	2875	2681	3517	1910
95	26K0330	03	0324	0353	320	327	2067	2432	2564	2160
95	26K0331	03	0324	0353	320	379	2460	2432	2956	2071
95	26K0332	03	0334	0357	320	282	1767	2431	2125	2242
95	26K0333	03	0334	0358	320	334	2148	2558	2644	2201
95	26K0338	03	0345	1004	260	244	1645	1879	1810	2186
95	26K0339	03	0345	1005	260	297	1842	1880	2194	1991
95	26K0345	03	0357	1027	260	494	3004	705	3578	1475
95	26K0344	03	0357	1032	261	455	2840	539	3298	1467
95	27K0302	03	1008	1071	260	636	3909	671	4885	1488
95	27K0308	03	1015	1039	260	207	1245	670	1513	1656
95	27K0307	03	1015	1050	260	360	2168	671	2602	1511
95	27K0309	03	1019	1043	260	299	1795	671	2184	1555
95	27K0310	03	1019	1047	260	198	1167	671	1439	1655
95	27K0311	03	1022	1054	260	436	2748	671	3254	1531
95	27K0312	03	1022	1055	260	430	2744	671	3211	1541
95	27K0319	03	1035	1062	260	233	1443	1965	1728	1518
95	27K0320	03	1035	1064	260	420	2575	738	3196	1550
95	27K0337	03	1053	1078	260	264	1740	671	2346	1802
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95	27K0352	03	1064	1096	380	300	1872	1063	2404	1780
95	27K0354	03	1070	1102	380	418	2551	1063	3239	1639
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95	27K0356	03	1075	1111	380	587	3526	1063	4516	1551
95	27K0362	03	1081	1106	380	300	1807	1063	2295	1722
95	27K0361	03	1081	1118	380	462	2727	1155	3481	1594
95	27K0363	03	1085	1111	380	306	1840	1063	2276	1692
95	28K0305	03	1096	1125	380	318	1924	3954	2305	2573
95	28K0308	03	1105	1127	380	368	2283	3954	2687	2425
95	28K0319	03	1109	1133	380	189	1146	3954	1346	3411
95	28K0321	03	1111	1145	380	336	2021	3954	2399	2492
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95	28K0334	03	1131	1155	380	280	1675	3954	1855	2673
95	28K0337	03	1138	1162	380	378	2313	3954	2409	2295
95	28K0338	03	1138	1162	380	265	1607	3954	1689	2736
95	28K0339	03	1140	1163	380	351	2169	3954	2304	2402
95	28K0350	03	1148	1169	380	143	889	3954	881	4003
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95	28K0351	03	1153	1173	380	261	1652	3954	1621	2769
95	28K0352	03	1153	1174	380	344	2161	3954	2221	2423
95	28K0353	03	1159	1182	350	343	2057	3566	2208	2283
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95	28K0348	04	0145	0182	450	412	2390	453	2708	1347
95	28K0345	04	0147	0190	450	568	3276	2598	3868	1715
95	28K0346	04	0148	0182	390	391	2236	498	2593	1362
95	28K0347	04	0148	0189	390	256	1478	924	1736	1616
95	28K0355	04	0152	0195	390	531	3059	1135	3727	1492
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95	28K0357	04	0154	0190	390	544	3154	13381	3770	3733
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95	28K0358	04	0159	0205	390	703	4222	789	5428	1485
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95	28K0350	04	0161	0190	390	294	1696	1152	2009	1652
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95	28K0352	04	0163	0197	390	242	1385	909	1845	1710
95	28K0351	04	0163	0198	390	340	1982	792	2591	1578
95	28K0367	04	0166	0203	390	667	3907	9346	5040	2743
95	28K0366	04	0167	0204	390	453	2643	1066	3442	1579
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95	28K0360	04	0169	0202	390	264	1631	848	2001	1697
95	28K0363	04	0173	0202	390	219	1267	442	1701	1557
95	28K0371	04	0173	0224	390	594	3681	589	4703	1511
95	28K0365	04	0175	0203	390	135	793	453	979	1648
95	28K0372	04	0175	0237	390	849	5118	10354	9853	2983
95	28K0370	04	0180	0202	390	148	845	453	1148	1653
95	25K0325	04	0208	0243	450	577	3511	2807	4697	1909
95	25K0326	04	0209	0247	450	681	4107	2280	5628	1764
95	25K0333	04	0217	0253	450	380	2367	2280	3147	2051
95	25K0334	04	0218	0254	450	474	2843	2280	3878	1899
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95	25K0347	04	0243	0279	450	638	3665	2280	5198	1747
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95	25K0350	04	0251	0280	450	487	2831	2280	3821	1834
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95	25K0356	04	0257	0286	450	471	2721	3384	3577	2056

95	25K0357	04	0264	0300	450	717	4166	3384	5441	1812
95	25K0358	04	0265	0303	450	638	3802	3384	4772	1874
95	25K0360	04	0266	0306	450	840	4931	3384	6219	1730
95	25K0359	04	0267	0292	450	553	3191	3384	3264	1779
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95	25K0361	04	0271	0300	450	485	2872	3384	3467	2005
95	25K0362	04	0272	0303	450	578	3372	3384	4132	1884
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95	26K0301	04	0280	0310	450	575	3376	3414	4082	1891
95	26K0302	04	0282	0310	450	672	3951	3414	4877	1822
95	26K0303	04	0285	0324	450	513	3074	3414	3718	1989
95	26K0304	04	0286	0314	450	324	1877	3414	2293	2341
95	26K0311	04	0292	0323	450	343	2016	3414	2426	2290
95	26K0305	04	0293	0321	450	641	3737	3536	4594	1851
95	26K0312	04	0293	0336	450	423	2416	3414	3040	2096
95	26K0313	04	0299	0342	450	393	2303	3414	2824	2173
95	26K0318	04	0300	0342	450	628	3645	3414	4516	1843
95	26K0321	04	0306	0343	450	559	3321	3414	4061	1931
95	26K0322	04	0307	0339	450	394	2442	3414	2861	2212
95	26K0323	04	0307	0345	450	422	2533	3414	3064	2135
95	26K0324	04	0313	0346	450	387	2384	3414	2825	2228
95	26K0325	04	0314	0353	450	438	2754	3414	3300	2162
95	26K0326	04	0316	0349	450	380	2313	3415	2833	2253
95	26K0327	04	0317	0352	450	598	3620	3415	4445	1920
95	26K0334	04	0320	0353	450	563	3385	3314	4169	1930
95	26K0329	04	0321	0356	450	447	2805	3415	3230	1679
95	26K0335	04	0321	1012	450	680	4062	3242	5013	1811
95	26K0336	04	0327	1011	450	426	2613	3242	3104	2103
95	26K0337	04	0328	1012	450	725	4434	3242	5382	1801
95	26K0342	04	0349	1020	540	567	3510	3921	4134	2040
95	26K0343	04	0350	1021	540	462	2875	3921	3347	2195
95	27K0303	04	1004	1032	540	601	3727	1398	4312	1570
95	27K0304	04	1004	1032	540	449	2703	1397	3220	1630
95	27K0313	04	1011	1042	540	359	2226	1397	2567	1724
95	27K0305	04	1012	1048	540	512	3096	1397	3733	1607
95	27K0314	04	1020	1055	540	457	2933	1397	3277	1665
95	27K0321	04	1022	1074	540	738	4589	1397	5523	1559
95	27K0322	04	1027	1062	540	486	3088	1475	3522	1664
95	27K0331	04	1028	1056	540	469	2939	1398	3462	1663
95	27K0332	04	1029	1061	540	404	2569	1398	2975	1718
95	27K0323	04	1033	1070	540	620	3914	1397	4620	1601
95	27K0333	04	1034	1075	540	665	4192	1398	5060	1602
95	27K0334	04	1040	1074	540	677	4253	1397	5130	1592
95	27K0335	04	1047	1074	540	381	2477	1398	2977	1798
95	27K0336	04	1049	1083	540	550	3727	1397	4625	1773
95	27K0343	04	1053	1081	540	383	2525	1397	3174	1853
95	27K0344	04	1054	1078	540	514	3491	1398	4437	1814
95	27K0345	04	1054	1082	540	588	3805	1397	4990	1733

95	27K0346	04	1055	1083	540	575	3739	1398	4916	1748
95	27K0347	04	1057	1091	560	646	3979	1397	5218	1640
95	27K0348	04	1061	1074	540	75	497	1397	634	3371
95	27K0349	04	1062	1074	540	86	556	1398	741	3134
95	27K0350	04	1063	1091	560	124	747	1574	983	2665
95	27K0357	04	1068	1095	560	473	2875	1574	3740	1731
95	27K0358	04	1069	1099	560	736	4438	1574	5872	1615
95	27K0359	04	1076	1109	560	675	4099	1574	5123	1599
95	27K0360	04	1077	1110	560	663	4038	1574	4969	1596
95	27K0367	04	1082	1117	560	514	3121	1747	3756	1678
95	27K0368	04	1085	1117	560	400	2431	1713	2922	1767
95	27K0369	04	1090	1123	560	692	4215	1713	5018	1582
95	28K0301	04	1091	1123	560	460	2829	5823	3311	2601
95	27K0302	04	1092	1120	560	622	3731	5823	4497	2259
95	28K0303	04	1092	1124	560	449	2713	5823	3247	2624
95	28K0310	04	1095	1126	560	613	3686	5823	4412	2271
95	28K0311	04	1096	1127	560	341	2049	5823	2421	3018
95	28K0312	04	1098	1127	560	370	2258	5823	2663	2904
95	28K0313	04	1099	1132	560	645	4004	5823	4603	2237
95	28K0314	04	1102	1133	560	474	2928	5823	3383	2560
95	28K0315	04	1103	1134	560	414	2497	5823	2957	2724
95	28K0307	04	1103	1140	560	607	3686	5823	4404	2292
95	28K0316	04	1104	1140	560	404	2439	5823	2890	2760
95	28K0317	04	1105	1140	560	490	3015	5823	3500	2518
95	28K0324	04	1109	1139	560	360	2173	5823	2596	2942
95	28K0318	04	1109	1140	560	465	2763	5823	3294	2555
95	28K0325	04	1110	1141	560	864	5275	5823	6175	1999
95	28K0327	04	1112	1145	560	469	2926	5823	3343	2578
95	28K0323	04	1116	1147	560	635	3997	5823	4478	2252
95	28K0328	04	1116	1153	560	503	3147	5823	3485	2476
95	28K0329	04	1117	1147	560	378	2298	5823	2658	2852
95	28K0330	04	1118	1149	560	609	3924	5823	4114	2276
95	28K0341	04	1123	1156	560	467	2854	5823	3135	2529
95	28K0342	04	1124	1153	560	620	3927	5823	4245	2257
95	28K0343	04	1131	1148	560	415	2689	5892	2810	2745
95	28K0344	04	1132	1166	560	605	3776	5823	4029	2253
95	28K0345	04	1133	1169	560	693	4326	5823	4619	2131
95	28K0336	04	1135	1161	560	603	3946	5823	3883	2264
95	28K0346	04	1138	1166	560	419	2671	5823	2675	2666
95	28K0340	04	1140	1172	560	498	3193	5823	3171	2447
95	28K0347	04	1146	1173	560	636	4133	5823	3967	2189
95	28K0348	04	1149	1174	560	399	2581	5823	3521	2738
95	28K0355	04	1155	1188	500	605	3736	5215	3731	2096
95	28K0356	04	1166	1194	500	703	4284	6133	4474	2118
95	28K0357	04	1166	1196	500	738	4481	6133	5117	2132
95	28K0361	04	1172	1195	500	307	1847	919	2006	1554
95	28K0360	04	1172	1202	500	821	5036	6133	6259	2123
95	28K0365	04	1180	1208	500	509	3097	4484	3970	2269

```
C*****************************************************************************
C
C                              APPENDIX B
C
C*****************************************************************************
C
C
C        COMPUTATION OF DAILY STATISTICS FOR  NARF ( AIRCRAFT )
C
C
C     ASSUMPTIONS
C        (1) ALL MANHOURS AND COSTS ARE UNIFORMLY DISTRIBUTED OVER THE
C         # OF DAYS IN THE SHOP
C        (2) WORK BEGINS ON ENTRANCE DATE BUT NO WORK IS DONE ON EXIT DAY.
C        (3) A SEVEN DAY WORK WEEK IS ASSUMED FOR COMPUTATION PURPOSES.
C
C     SUB-ROUTINES REQUIRED
C        TALLY AND UTPLOT, BOTH PROGRAMS LISTED IN APPENDIX D.
C
C     INPUTS REQUIRED
C
C        EARLIEST ENTRANCE JULIAN DATE ( NO EARLIER THAN CY 1970 )
C        LATEST EXIT JULIAN DATE ( NO LATER THAN CY 1971 )
C        NUMBER OF DATA CARDS
C        FORMAT (2X,I4,2X,I4,2X,I4).
C
C        DATA CARDS ARE TO BE IN STANDARD FORMAT PREPARED FOR THESIS WORK.
C
C
C*****************************************************************************
      DIMENSION ABOX(700),BBOX(700),CBOX(700),DBOX(700),EBOX(700)
      DIMENSION XBOX(700),RANGE(4)
      DATA ABOX,BBOX,CBOX,DBOX,EBOX/700*0.0,700*0.0,700*0.0,700*0.0,
     6700*0.0/
      DATA LK,MODCUR,ERROR/1,0,0.0/
      READ (5,9000) JSTART,JSTOP,NCARD
 9000 FORMAT (2X,I4,2X,I4,2X,I4)
      DO 1000 I=1,NCARD,1
      READ (5,9001,END=9999) IN,IOUT,NORM,MH,LAB,MAT
 9001 FORMAT (14X,I4,1X,I4,1X,I5,7X,I5,1X,I6,1X,I6)
      IDAYS=IOUT-IN
      IF (IDAYS.GE.635) IDAYS=IDAYS-635
      IF (IDAYS.LE.0) ERROR=ERROR+1.0
      PNORM=FLOAT(NORM)/FLOAT(IDAYS)
      PMH=FLOAT(MH)/FLOAT(IDAYS)
      PLAB=FLOAT(LAB)/FLOAT(IDAYS)
      PMAT=FLOAT(MAT)/FLOAT(IDAYS)
      JDAYS=IN-JSTART+1
```

```
      IF (JDAYS.GE.635) JDAYS=JDAYS-635 .
      KDAYS=IDAYS+JDAYS-1
      DO 1000 J=JDAYS,KDAYS,1
      ABOX(J)=ABOX(J)+PNORM
      BBOX(J)=BBOX(J)+PMH
      CBOX(J)=CBOX(J)+PLAB
      DBOX(J)=DBOX(J)+PMAT
      EBOX(J)=EBOX(J)+1.0
 1000 CONTINUE
C***********************************************************************
C
C
C        PRINT COMPJTED DATA
C
C
C***********************************************************************
 9999 WRITE(6,9500) JSTART,JSTOP,NCARD
 9500 FORMAT ('1',////,18X,'SUMMARY OF DAILY STATISTICS OF NARF',
     1'  ( AIRCRAFT )',/,27X,
     1'DATA FOR JULIAN DATES ',I4,' TO ',I4,/,27X,
     2'TOTAL NUMBER OF OBSERVATIONS =',I4,///,17X,'JULIAN',16X,'DIRECT',
     35X,'DIRECT',6X,'DIRECT',6X,'NO.IN',/,10X,'DAY',4X,'DATE',7X,
     4'NORM',7X,'MANHOURS',3X,'LABOR COST',2X,'MATL COST',3X,'SHOP',/)
      K=JSTOP-JSTART
      IF(K.GE.635)K=K-634
      LDAYS=JSTART
      DO 2000 I=1,K,1
      WRITE (6,9501) I,LDAYS,ABOX(I),BBOX(I),CBOX(I),DBOX(I),
     6EBOX(I)
 9501 FORMAT (9X,I4,4X,I4,4F12.2,5X,F4.0)
      XBOX(I)=FLOAT(I)
      LDAYS=LDAYS+1
      IF(LDAYS.EQ.0366)LDAYS=1001
 2000 CONTINUE
C***********************************************************************
C
C
C         PLOTTING PACKAGE FOR COMPUTED DATA
C
C
C***********************************************************************
      RANGE(1)=560.0
      RANGE(2)=0.0
      RANGE(3)=10000.0
      RANGE(4)=1000.0
      WRITE (6,9502)
 9502 FORMAT ('1',//)
      CALL UTPLOT (XBOX,ABOX,K,RANGE,LK,MODCUR)
```

```
      WRITE (6,9503)
 9503 FORMAT (///,20X,'GRAPH OF    PRORATED NORM  ( Y AXIS ) VS ',
     6'DAYS ( X AXIS )  FOR AIRCRAFT')
      WRITE (6,9502)
      CALL UTPLOT (XBOX,BBOX,K,RANGE,LK,MODCUR)
      WRITE (6,9504)
 9504 FORMAT (///,20X,'GRAPH OF DIRECT MAN HOURS  ( Y AXIS ) VS ',
     6'DAYS ( X AXIS )  FOR AIRCRAFT')
      RANGE(3)=65000.0
      RANGE(4)=5000.0
      WRITE (6,9502)
      CALL UTPLOT (XBOX,CBOX,K,RANGE,LK,MODCUR)
      WRITE (6,9505)
 9505 FORMAT (///,20X,'GRAPH OF DIRECT LABOR COST ( Y AXIS ) VS ',
     6'DAYS ( X AXIS )  FOR AIRCRAFT')
      WRITE (6,9502)
      CALL UTPLOT (XBOX,DBOX,K,RANGE,LK,MODCUR)
      WRITE (6,9506)
 9506 FORMAT (///,20X,'GRAPH OF DIRECT MATL COST  ( Y AXIS ) VS ',
     6'DAYS ( X AXIS )  FOR AIRCRAFT')
      RANGE(3)=120.0
      RANGE(4)=0.0
      WRITE (6,9502)
      CALL UTPLOT (XBOX,EBOX,K,RANGE,LK,MODCUR)
      WRITE (6,9507)
 9507 FORMAT (///,20X,'GRAPH OF NO. JOBS IN SHOP  ( Y AXIS ) VS ',
     6'DAYS ( X AXIS )  FOR AIRCRAFT')
      DO 1500 I=140,420,1
      J=I-139
      ABOX(J)=ABOX(I)
      BBOX(J)=BBOX(I)
      CBOX(J)=CBOX(I)
      DBOX(J)=DBOX(I)
      EBOX(J)=EBOX(I)
      XBOX(J)=FLOAT(I)
 1500 CONTINUE
      K=281
      RANGE(1)=420.0
      RANGE(2)=140.0
      RANGE(3)=9500.0
      RANGE(4)=6500.0
      WRITE (6,9502)
      CALL UTPLOT (XBOX,ABOX,K,RANGE,LK,MODCUR)
      WRITE (6,9503)
      RANGE(3)=10000.0
      RANGE(4)=7000.0
      WRITE (6,9502)
      CALL UTPLOT (XBOX,BBOX,K,RANGE,LK,MODCUR)
```

```
      WRITE (6,9504)
      RANGE(3)=65000.0
      RANGE(4)=35000.0
      WRITE (6,9502)
      CALL UTPLOT (XBOX,CBOX,K,RANGE,LK,MODCUR)
      WRITE (6,9505)
      RANGE(3)=27000.0
      RANGE(4)=15000.0
      WRITE (6,9502)
      CALL UTPLOT (XBOX,DBOX,K,RANGE,LK,MODCUR)
      WRITE (6,9506)
      RANGE(3)=90.0
      RANGE(4)=60.0
      WRITE (6,9502)
      CALL UTPLOT (XBOX,EBOX,K,RANGE,LK,MODCUR)
      WRITE (6,9507)
      WRITE (6,9502)
      WRITE (6,9508) ERROR
 9508 FORMAT (10X,'NUMBER OF ERRORS =',F3.0)
      STOP
      END
```

```
C*************************************************************************
C
C
C      COMPUTATION OF DAILY STATISTICS FOR  NARF ( ENGINES )
C
C
C     ASSUMPTIONS
C       (1) ALL MANHOURS AND COSTS ARE UNIFORMLY DISTRIBUTED OVER THE
C        # OF DAYS IN THE SHOP
C       (2) WORK BEGINS ON ENTRANCE DATE BUT NO WORK IS DONE ON EXIT DAY.
C       (3) A SEVEN DAY WORK WEEK IS ASSUMED FOR COMPUTATION PURPOSES.
C

      SUBROUTINES REQUIRED:
C       TALLY AND UTPLOT, BOTH PROGRAMS LISTED IN APPENDIX D.
C
C     INPUTS REQUIRED
C
C       EARLIEST ENTRANCE JULIAN DATE ( NO EARLIER THAN CY 1970 )
C       LATEST EXIT JULIAN DATE ( NO LATER THAN CY 1971 )
C       NUMBER OF DATA CARDS
C       FORMAT (2X,I4,2X,I4,2X,I4).
C
C       DATA CARDS ARE TO BE IN STANDARD FORMAT PREPARED FOR THESIS WORK.
C
C
C*************************************************************************
      DIMENSION ABOX(700),BBOX(700),CBOX(700),DBOX(700),EBOX(700)
      DIMENSION XBOX(700),RANGE(4)
      DATA ABOX,BBOX,CBOX,DBOX,EBOX/700*0.0,700*0.0,700*0.0,700*0.0,
     6700*0.0/
      DATA LK,MODCUR,ERROR/1,0,0.0/
      READ (5,9000) JSTART,JSTOP,NCARD
 9000 FORMAT (2X,I4,2X,I4,2X,I4)
      DO 1000 I=1,NCARD,1
      READ (5,9001,END=9999) IN,IOUT,NORM,MH,LAB,MAT
 9001 FORMAT (14X,I4,1X,I4,1X,I5,7X,I5,1X,I6,1X,I6)
      IDAYS=IOUT-IN
      IF (IDAYS.GE.635) IDAYS=IDAYS-635
      IF (IDAYS.LE.0) ERROR=ERROR+1.0
      PNORM=FLOAT(NORM)/FLOAT(IDAYS)
      PMH=FLOAT(MH)/FLOAT(IDAYS)
      PLAB=FLOAT(LAB)/FLOAT(IDAYS)
      PMAT=FLOAT(MAT)/FLOAT(IDAYS)
      JDAYS=IN-JSTART+1
      IF (JDAYS.GE.635) JDAYS=JDAYS-635
      KDAYS=IDAYS+JDAYS-1
```

```
      DO 1000 J=JDAYS,KDAYS,1
      ABOX(J)=ABOX(J)+PNORM
      BBOX(J)=BBOX(J)+PMH
      CBOX(J)=CBOX(J)+PLAB
      DBOX(J)=DBOX(J)+PMAT
      EBOX(J)=EBOX(J)+1.0
 1000 CONTINUE
C***********************************************************************
C
C
C         PRINT COMPUTED DATA
C
C
C***********************************************************************
 9999 WRITE(6,9500) JSTART,JSTOP,NCARD
 9500 FORMAT ('1',////,18X,'SUMMARY OF DAILY STATISTICS OF NARF',
     1'   ( ENGINES ) ',/,27X,
     1'DATA FOR JULIAN DATES ',I4,' TO ',I4,/,27X,
     2'TOTAL NUMBER OF OBSERVATIONS =',I4,///,17X,'JULIAN',16X,'DIRECT',
     35X,'DIRECT',6X,'DIRECT',6X,'NO.IN',/,10X,'DAY',4X,'DATE',7X,
     4'NORM',7X,'MANHOURS',3X,'LABOR COST',2X,'MATL COST',3X,'SHOP',/)
      K=JSTOP-JSTART
      IF(K.GE.635)K=K-634
      LDAYS=JSTART
      DO 2000 I=1,K,1
      WRITE (6,9501) I,LDAYS,ABOX(I),BBOX(I),CBOX(I),DBOX(I),
     6EBOX(I)
 9501 FORMAT (9X,I4,4X,I4,4F12.2,5X,F4.0)
      XBOX(I)=FLOAT(I)
      LDAYS=LDAYS+1
      IF(LDAYS.EQ.0366)LDAYS=1001
 2000 CONTINUE
C***********************************************************************
C
C
C          PLOTTING PACKAGE FOR COMPUTED DATA
C
C
C***********************************************************************
      RANGE(1)=480.0
      RANGE(2)=0.0
      RANGE(3)=3000.0
      RANGE(4)=0.0
      WRITE (6,9502)
 9502 FORMAT ('1',//)
      CALL UTPLOT (XBOX,ABOX,K,RANGE,LK,MODCUR)
      WRITE (6,9503)
 9503 FORMAT (///,20X,'GRAPH OF    PRORATED NORM  ( Y AXIS ) VS ',
```

```
     6'DAYS ( X AXIS )  FOR ENGINES')
      WRITE (6,9502)
      CALL UTPLOT (XBOX,BBOX,K,RANGE,LK,MODCUR)
      WRITE (6,9504)
 9504 FORMAT (///,20X,'GRAPH OF DIRECT MAN HOURS  ( Y AXIS ) VS ',
     6'DAYS ( X AXIS )  FOR ENGINES')
      RANGE(3)=30000.0
      WRITE (6,9502)
      CALL UTPLOT (XBOX,CBOX,K,RANGE,LK,MODCUR)
      WRITE (6,9505)
 9505 FORMAT (///,20X,'GRAPH OF DIRECT LABOR COST ( Y AXIS ) VS ',
     6'DAYS ( X AXIS )  FOR ENGINES')
      WRITE (6,9502)
      CALL UTPLOT (XBOX,DBOX,K,RANGE,LK,MODCUR)
      WRITE (6,9506)
 9506 FORMAT (///,20X,'GRAPH OF DIRECT MATL COST  ( Y AXIS ) VS ',
     6'DAYS ( X AXIS )  FOR ENGINES')
      RANGE(3)=180.0
      WRITE (6,9502)
      CALL UTPLOT (XBOX,EBOX,K,RANGE,LK,MODCUR)
      WRITE (6,9507)
 9507 FORMAT (///,20X,'GRAPH OF NO. JOBS IN SHOP  ( Y AXIS ) VS ',
     6'DAYS ( X AXIS )  FOR ENGINES')
      DO 1500 I=30,430,1
      J=I-29
      ABOX(J)=ABOX(I)
      BBOX(J)=BBOX(I)
      CBOX(J)=CBOX(I)
      DBOX(J)=DBOX(I)
      EBOX(J)=EBOX(I)
      XBOX(J)=FLOAT(I)
 1500 CONTINUE
      K=401
      RANGE(1)=430.0
      RANGE(2)=30.0
      RANGE(3)=2600.0
      RANGE(4)=1400.0
      WRITE (6,9502)
      CALL UTPLOT (XBOX,ABOX,K,RANGE,LK,MODCUR)
      WRITE (6,9503)
      WRITE (6,9502)
      CALL UTPLOT (XBOX,BBOX,K,RANGE,LK,MODCUR)
      WRITE (6,9504)
      RANGE(3)=15000.0
      RANGE(4)=9000.0
      WRITE (6,9502)
      CALL UTPLOT (XBOX,CBOX,K,RANGE,LK,MODCUR)
      WRITE (6,9505)
```

```
      RANGE(3)=28000.0
      RANGE(4)=13000.0
      WRITE (6,9502)
      CALL UTPLOT (XBOX,DBOX,K,RANGE,LK,MODCUR)
      WRITE (6,9506)
      RANGE(3)=170.0
      RANGE(4)=80.0
      WRITE (6,9502)
      CALL UTPLOT (XBOX,EBOX,K,RANGE,LK,MODCUR)
      WRITE (6,9507)
      WRITE (6,9502)
      WRITE (6,9508) ERROR
 9508 FORMAT (10X,'NUMBER OF ERRORS =',F3.0)
      STOP
      END
```

```
C***********************************************************************
C
C                        APPENDIX C
C
C     THIS PROGRAM TALLIES THE JOBS ACCORDING TO THE NUMBER
C     OF DAYS REQUIRED FOR COMPLETION OF WORK. THE DISTRIBUTION
C     IS DISPLAYED GRAPHICLY AND THE 95TH PERCENTILE OF THAT
C     DISTRIBUTION IS FOUND.
C
C
C    SUBROUTINES REQUIRED:
C     TALLY AND UTPLOT, BOTH PROGRAMS LISTED IN APPENDIX D
C
C    INPUTS REQUIRED:
C     (1) NUMBER OF DATA CARDS= NCARD
C     (2) TYPE JOB(AIRCRAFT OR ENGINE)=ITP
C     (3) DATA CARDS WITH JOB INDATE=IN AND OUTDATE=IOUT
C
C    OUTPUT
C     (1) GRAPH OF JOB DISTRIBUTION
C     (2) AVERAGE NUMBER OF DAYS JOBS IN THE SHOP
C     (3) STANDARD DEVIATION OF DISTRIBUTION
C     (4) MINIMUM NUMBER OF DAYS IN SHOP
C     (5) MAXIMUM NUMBER OF DAYS IN SHOP
C     (6) DAY NUMBER WHEN 95% OF THE JOBS ARE COMPLETE
C
C***********************************************************************
C
      DIMENSION A(1600),S(1600),XBOX(500),YBOX(500),TYPE(2)
      DIMENSION TOTAL(1),AVER(1),SD(1),VMIN(1),VMAX(1),RANGE(4)
      REAL*8 TYPE
      DATA TYPE/'AIRCRAFT','ENGINES '/
      DATA S,NV,IER,LK,MODCUR/1600*1.0,1,0,1,0/
      DATA YBOX/500*0.0/
      DATA ZBOX/0.0/
      READ (5,9001) NCARD,ITP
 9001 FORMAT (2I4)
      DO 1000 I=1,NCARD,1
      READ (5,9002,END=9999) IN,IOUT
 9002 FORMAT (14X,I4,1X,I4)
      IDAYS=IOUT-IN
      IF (IDAYS.GE.635) IDAYS=IDAYS-635
      A(I)=FLOAT(IDAYS)
 1000 CONTINUE
 9999 CALL TALLY (A,S,TOTAL,AVER,SD,VMIN,VMAX,NCARD,NV,IER)
      RANGE(1)=VMAX(1)
      RANGE(2)=VMIN(1)
      RANGE(3)=0.0
```

```
      RANGE(4)=0.0
      JK=VMIN(1)
      JL=VMAX(1)
      NPAIR=JL-JK+1
      DO 1500 I=JK,JL,1
      K=I-JK+1
      XBOX(K)=FLOAT(I)
 1500 CONTINUE
      DO 2000 I=1,NCARD,1
      LA=A(I)
      JM=LA-JK+1
      YBOX(JM)=YBOX(JM)+1.0
 2000 CONTINUE
      SUMX =0.05*FLOAT(NCARD)
      DO 2500 J=1,NPAIR,1
      IF(YBOX(J).GT.RANGE(3)) RANGE(3)=YBOX(J)
      NP=NPAIR-J+1
      ZBOX=ZBOX+YBOX(NP)
      IF(ZBOX.GE.SUMX) GO TO 2501
 2500 CONTINUE
 2501 IF(ZBOX.GT.SUMX) NP=NP+1
      WRITE (6,9500)
 9500 FORMAT ('1')
      CALL UTPLOT (XBOX,YBOX,NPAIR,RANGE,LK,MODCUR)
      WRITE (6,9501)TYPE(ITP),AVER,SD,VMIN,VMAX,NP
 9501 FORMAT (///,30X,'GRAPH OF NUMBER OF DAYS EACH JOB IS IN SHOP ',
     1'(',A8,')',  //,40X,'MEAN=',F6.2,/,40X,'STD DEV=',F7.2,/,40X,
     2'MIN NO. OF DAYS IN SHOP=',F5.1,/,40X,'MAX NO. OF DAYS IN SHOP=',
     3F5.1,/,40X,'95TH PERCENTILE OF ABOVE DISTRIBUTION = ',I3)
      WRITE (6,9500)
      STOP
      END
```

```
C*******************************************************************
C
C                         APPENDIX D
C
C*******************************************************************
C
C     THE SUB-ROUTINES LISTED IN THIS APPENDIX HAVE BEEN
C     USED IN THE PROGRAMS IN APPENDIX B AND C. THE COMMENT
C     CARDS WERE LEFT IN THE PROGRAMS FOR EASIER USE OF
C     THE ROUTINES.
C                                                                   TALL  10
C     ..............................................................TALL  20
C                                                                   TALL  30
C        SUBROUTINE TALLY                                           TALL  40
C                                                                   TALL  50
C        PURPOSE                                                    TALL  60
C           CALCULATE TOTAL, MEAN, STANDARD DEVIATION, MINIMUM, MAXIMUM TALL  70
C           FOR EACH VARIABLE IN A SET (OR A SUBSET) OF OBSERVATIONS   TALL  80
C                                                                   TALL  90
C        USAGE                                                      TALL 100
C           CALL TALLY(A,S,TOTAL,AVER,SD,VMIN,VMAX,NO,NV,IER)       TALL 110
C                                                                   TALL 120
C        DESCRIPTION OF PARAMETERS                                  TALL 130
C           A      - OBSERVATION MATRIX, NO BY NV                   TALL 140
C           S      - INPUT VECTOR INDICATING SUBSET OF A. ONLY THOSE   TALL 150
C                    OBSERVATIONS WITH A NON-ZERO S(J) ARE CONSIDERED. TALL 160
C                    VECTOR LENGTH IS NO.                           TALL 170
C           TOTAL  - OUTPUT VECTOR OF TOTALS OF EACH VARIABLE. VECTOR  TALL 180
C                    LENGTH IS NV.                                  TALL 190
C           AVER   - OUTPUT VECTOR OF AVERAGES OF EACH VARIABLE. VECTOR TALL 200
C                    LENGTH IS NV.                                  TALL 210
C           SD     - OUTPUT VECTOR OF STANDARD DEVIATIONS OF EACH   TALL 220
C                    VARIABLE. VECTOR LENGTH IS NV.                 TALL 230
C           VMIN   - OUTPUT VECTOR OF MINIMA OF EACH VARIABLE. VECTOR  TALL 240
C                    LENGTH IS NV.                                  TALL 250
C           VMAX   - OUTPUT VECTOR OF MAXIMA OF EACH VARIABLE. VECTOR  TALL 260
C                    LENGTH IS NV.                                  TALL 270
C           NO     - NUMBER OF OBSERVATIONS                         TALL 280
C           NV     - NUMBER OF VARIABLES FOR EACH OBSERVATION       TALL 290
C           IER    - ZERO, IF NO ERROR.                             TALL 291
C                  - 1, IF S IS NULL.  VMIN=-1.E75, VMAX=SD=AVER=1.E75. TALL 292
C                  - 2, IF S HAS ONLY ONE NON-ZERO ELEMENT. VMIN=VMAX.  TALL 293
C                    SD=0.0                                         TALL 294
C                                                                   TALL 300
C                                                                   TALL 330
C        SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED              TALL 340
C           NONE                                                    TALL 350
C                                                                   TALL 360
```

```
C        METHOD                                                          TALL 370
C           ALL OBSERVATIONS CORRESPONDING TO A NON-ZERO ELEMENT IN S    TALL 380
C           VECTOR ARE ANALYZED FOR EACH VARIABLE IN MATRIX A.           TALL 390
C           TOTALS ARE ACCUMULATED AND MINIMUM AND MAXIMUM VALUES ARE    TALL 400
C           FOUND. FOLLOWING THIS, MEANS AND STANDARD DEVIATIONS ARE     TALL 410
C           CALCULATED.  THE DIVISOR FOR STANDARD DEVIATION IS ONE LESS TALL 420
C           THAN THE NUMBER OF OBSERVATIONS USED.                        TALL 430
C                                                                        TALL 440
C     ...................................................................TALL 450
C                                                                        TALL 460
C
C
C
C

      SUBROUTINE TALLY(A,S,TOTAL,AVER,SD,VMIN,VMAX,NO,NV,IER)           TALL 470
      DIMENSION A(1),S(1),TOTAL(1),AVER(1),SD(1),VMIN(1),VMAX(1)        TALL 480
C                                                                        TALL 490
C        CLEAR OUTPUT VECTORS AND INITIALIZE VMIN,VMAX                   TALL 500
C                                                                        TALL 510
      IER=0                                                              TALL 511
      DO 1 K=1,NV                                                        TALL 520
      TOTAL(K)=0.0                                                       TALL 530
      AVER(K)=0.0                                                        TALL 540
      SD(K)=0.0                                                          TALL 550
      VMIN(K)= 1.0E75                                                    TALL 560
    1 VMAX(K)=-1.0E75                                                    TALL 570
C                                                                        TALL 580
C        TEST SUBSET VECTOR                                              TALL 590
C                                                                        TALL 600
      SCNT=0.0                                                           TALL 610
      DO 7 J=1,NO                                                        TALL 620
      IJ=J-NO                                                            TALL 630
      IF(S(J)) 2,7,2                                                     TALL 640
    2 SCNT=SCNT+1.0                                                      TALL 650
C                                                                        TALL 660
C        CALCULATE TOTAL, MINIMA, MAXIMA                                 TALL 670
C                                                                        TALL 680
      DO 6 I=1,NV                                                        TALL 690
      IJ=IJ+NO                                                           TALL 700
      TOTAL(I)=TOTAL(I)+A(IJ)                                            TALL 710
      IF(A(IJ)-VMIN(I)) 3,4,4                                            TALL 720
    3 VMIN(I)=A(IJ)                                                      TALL 730
    4 IF(A(IJ)-VMAX(I)) 6,6,5                                            TALL 740
    5 VMAX(I)=A(IJ)                                                      TALL 750
    6 SD(I)=SD(I)+A(IJ)*A(IJ)                                            TALL 760
    7 CONTINUE                                                           TALL 770
```

```
C                                                                       TALL 780
C        CALCULATE MEANS AND STANDARD DEVIATIONS                        TALL 790
C                                                                       TALL 800
      IF (SCNT)8,8,9                                                    TALL 801
    8 IER=1                                                             TALL 802
      DO 85 I=1,NV                                                      TALL 803
      VMIN(I)=-1.0E75                                                   TALL 804
      VMAX(I)=1.0E75                                                    TALL 805
      SD(I)=1.0E75                                                      TALL 806
      AVER(I)=1.0E75                                                    TALL 807
   85 CONTINUE                                                          TALL 808
      GO TO 15                                                          TALL 809
    9 DO 10 I=1,NV                                                      TALL 810
   10 AVER(I)=TOTAL(I)/SCNT                                             TALL 820
      IF (SCNT-1.0) 13,11,13                                            TALL 821
   11 IER=2                                                             TALL 822
      DO 12 I=1,NV                                                      TALL 823
   12 SD(I)=0.0                                                         TALL 824
      GO TO 15                                                          TALL 825
   13 DO 14 I=1,NV                                                      TALL 826
   14 SD(I)=SQRT(ABS((SD(I)-TOTAL(I)*TOTAL(I)/SCNT)/(SCNT-1.0)))        TALL 830
   15 RETURN                                                            TALL 840
      END                                                               TALL 850
```

```
C***********************************************************************
C                                                                       UTPL0020
C     SUBROUTINE UTPLOT                                                 UTPL0030
C                                                                       UTPL0040
C     PURPOSE                                                           UTPL0050
C                                                                       UTPL0060
C        PRINTS GRAPHS ON THE STANDARD OUTPUT PRINTER                   UTPL0070
C                                                                       UTPL0080
C     FEATURES                                                          UTPL0090
C                                                                       UTPL0100
C     1) FULL CONTROL OVER SCALING                                      UTPL0110
C     2) ABILITY TO PLOT SINGLE OR DOUBLE PRECISION VECTORS             UTPL0120
C                                                                       UTPL0130
C     CALLING SEQUENCE                                                  UTPL0140
C                                                                       UTPL0150
C     CALL UTPLOT(X,Y,N,RANGE,K,MODCUR)                                 UTPL0160
C                                                                       UTPL0170
C     DESCRIPTION OF ARGUMENTS                                          UTPL0180
C                                                                       UTPL0190
C     X      VECTOR OF ABSCISSAE                                        UTPL0200
C                                                                       UTPL0210
C     Y      VECTOR OF ASSOCIATED ORDINATES                             UTPL0220
C                                                                       UTPL0230
C     N      NUMBER OF (X,Y) PAIRS                                      UTPL0240
C                                                                       UTPL0250
C     RANGE  4 WORD SCALING VECTOR WHERE                                UTPL0260
C            RANGE(1)= MAXIMUM X TO BE PLOTTED                          UTPL0270
C            RANGE(2)= MINIMUM X TO BE PLOTTED                          UTPL0280
C            RANGE(3)= MAXIMUM Y TO BE PLOTTED                          UTPL0290
C            RANGE(4)= MINIMUM Y TO BE PLOTTED                          UTPL0300
C                                                                       UTPL0310
C            ALL (X,Y) POINTS OUTSIDE THE ABOVE RANGE WILL BE PLOTTED   UTPL0320
C            IN THE BORDER OF THE GRAPH.                                UTPL0330
C                                                                       UTPL0340
C     K      EVERY <TH ELEMENT OF X & Y WILL BE PLOTTED, E.G.,          UTPL0350
C            FOR REAL*4 DATA (SINGLE PRECISION) K=1                     UTPL0360
C            FOR REAL*8 DATA (DOUBLE PRECISION) K=2.                    UTPL0370
C                                                                       UTPL0380
C     MODCUR CONTROLS THE NUMBER OF CURVES ON ONE GRAPH                 UTPL0390
C            =0 THERE IS ONLY 1 CURVE ON THIS GRAPH                     UTPL0400
C            =1 THIS IS THE FIRST OF TWO OR MORE CURVES ON THIS GRAPH   UTPL0410
C            =2 THIS IS AN INTERMEDIATE CURVE ON THIS GRAPH             UTPL0420
C            =3 THIS IS THE LAST CURVE ON THIS GRAPH                    UTPL0430
C                                                                       UTPL0440
C     SCALING                                                           UTPL0450
C                                                                       UTPL0460
C            SCALING IS PERFORMED ONLY ON THE FIRST SET OF POINTS (WHEN UTPL0470
C        MODCUR = 0 OR 1.) ARRAY RANGE IS USED TO SET UP THE SCALE FAC- UTPL0480
```

```
C         TORS AND NEED ONLY BE DEFINED FOR THE FIRST CALL TO UTPLOT.
C
C      GRID LABELLING
C
C            THE DATA TO BE GRAPHED WILL BE FIT INTO AN 80 COLUMN BY
C         BY 60 ROW GRID. THE GRID WILL BE LABELLED THUSLY:
C
C         IN THE X DIRECTION (COLUMN-WISE), THERE WILL BE 5 VALUES:
C         THE MAXIMUM, THE MINIMUM, AND 3 INTERMEDIATE AT INCREMENTS OF
C         (RANGE(2)-RANGE(1))/4. FROM THE MINIMUM.
C
C         IN THE Y DIRECTION (ROW-WISE) THERE WILL BE 7 VALUES: THE MAXI-
C         MUM, THE MINIMUM, AND 5 INTERMEDIATE AT INCREMENTS OF
C         (RANGE(4)-RANGE(3))/6. FROM THE MINIMUM.
C
C         IF THE LABELS HAVE A VALUE BETWEEN 1. AND 10**8, THEY WILL BE
C         PRINTED IN AN F11.2 FORMAT, OTHERWISE THEY WILL BE PRINTED IN A
C         1PE10.3 FORMAT.
C
C      PLOTTING
C
C            FOUR CHARACTERS ARE USED FOR PLOTTING CURVES, ".","+","*",
C         AND "X". WHEN MORE THAN 4 CURVES ARE PLOTTED THE CHARACTERS
C         ARE USED REPEATEDLY.  IF A NEW CURVE IS TO BE PLACED IN THE
C         PLOTTING GRID WHERE AN OLD CURVE EXISTS, THE NEW CURVE REPLACES
C         THE OLD ONE. THUS, IF 3 IDENTICAL CURVES ARE PLOTTED, THEY WILL
C         APPEAR AS ONE CURVE COMPOSED OF "*"'S.
C
C      MESSAGES
C
C            UNDER CERTAIN CIRCUMSTANCES, A PLOT WILL NOT BE OUTPUT AND
C         ONE OF THE FOLLOWING MESSAGES WILL BE PRINTED ON THE STANDARD
C         OUTPUT IN PLACE OF THE PLOT.
C
C         "ALL Y-VALUES=0. CANNOT SETUP PLOT GRID. CHECK MAX & MIN Y
C          WHEN MODCUR=0 OR 1."
C
C         "ALL X VALUES=0. CANNOT SETUP PLOT GRID. CHECK MAX AND MIN X
C          WHEN MODCUR=0 OR 1."
C
C         "GRID NOT SETUP WHEN MODCUR LAST 0 OR 1. NO PLOT UNTIL GRID
C          PROPERLY SETUP."
C
C      NOTE
C
C            THE USER IS EXPECTED TO PROVIDE THE NECESSARY CARRIAGE
C         CONTROLS TO PLACE THE GRAPH PROPERLY ON THE PAGE.  BEFORE
C         CALLING UTPLOT THE USER SHOULD ISSUE A PRINT STATEMENT WHICH
```

```
C         EJECTS A PAGE SO THAT THE GRAPH WILL BE PLOTTED AT THE TOP       UTPL0970
C         OF THE NEXT PAGE. A TITLE CAN BE PRINTED AT THE BOTTOM OF        UTPL0980
C         THE GRAPH BY ISSUING A PRINT STATEMENT RIGHT AFTER CALLING       UTPL0990
C         THE SUBROUTINE.                                                   UTPL1000
C                                                                           UTPL1010
C.........................................................................UTPL1020
C                                                                           UTPL1030


      SUBROUTINE UTPLOT (X  ,Y  ,NDATA,RANGE,KKZ,MODCUR)                    UTPL1040
      DIMENSION GRID(61,81),XSCALE(5),YSCALE(7)                             UTPL1050
      DIMENSION X  (1),Y  (1),RANGE(4)                                      UTPL1060
      INTEGER*2 GRID,BLANK,DOT,XCHAR(4)/1H.,1H+,1H*,1HX/                    UTPL1070
      DATA DOT,BLANK/Z4B40,Z4040/                                           UTPL1080
      KDATA=NDATA*KKZ                                                       UTPL1090
      IF(MODCUR.GT.1) GO TO 444                                             UTPL1100
C                                                                           UTPL1110
C     GRID IS THE MATRIX USED TO PLOT THE POINTS                            UTPL1120
C                                                                           UTPL1130
      IERR=0                                                                UTPL1140
      XMAX=RANGE(1)                                                         UTPL1150
      XMIN=RANGE(2)                                                         UTPL1160
      YMAX=RANGE(3)                                                         UTPL1170
      YMIN=RANGE(4)                                                         UTPL1180
C                                                                           UTPL1190
C     CHECKING X AND Y POINTS AND PLOTTING THOSE OUT OF RANGE               UTPL1200
C     AT THE MARGIN                                                         UTPL1210
C                                                                           UTPL1220
      DO 30 I=1,KDATA,KKZ                                                   UTPL1230
      IF(X(I).GT.XMAX.OR.X(I).LT.XMIN.OR.Y(I).GT.YMAX.OR.Y(I).LT.YMIN)      UTPL1240
     1  IERR=IERR+1                                                         UTPL1250
      IF(X(I).LE.XMAX) GO TO 205                                            UTPL1260
      X  (I)=XMAX                                                           UTPL1270
      GOTO 210                                                              UTPL1280
  205 IF(X(I).GE.XMIN) GO TO 210                                            UTPL1290
      X  (I)=XMIN                                                           UTPL1300
  210 IF(Y(I).LE.YMAX) GO TO 215                                            UTPL1310
      Y  (I)=YMAX                                                           UTPL1320
      GOTO 30                                                               UTPL1330
  215 IF(Y(I).GE.YMIN) GO TO 30                                             UTPL1340
      Y  (I)=YMIN                                                           UTPL1350
C                                                                           UTPL1360
   30 CONTINUE                                                              UTPL1370
C                                                                           UTPL1380
C     PLOTTING X AND Y AXIS , IF NECESSARY                                  UTPL1390
C                                                                           UTPL1400
      JERR=0                                                                UTPL1410
      XRANGE=XMAX-XMIN                                                      UTPL1420
```

```
      YRANGE=YMAX-YMIN                                                  UTPL1430
      IF (YRANGE.NE.0.)  GO TO 298                                      UTPL1440
      IF(YMIN.EQ.0.) GO TO 889                                          UTPL1450
      YMIN=0.                                                           UTPL1460
      YRANGE=YMAX                                                       UTPL1470
      GO TO 299                                                         UTPL1480
  298 IF (XRANGE.NE.0.)  GO TO 299                                      UTPL1490
      IF(XMIN.EQ.0.) GO TO 887                                          UTPL1500
      XMIN=0.                                                           UTPL1510
      XRANGE=XMAX                                                       UTPL1520
C                                                                       UTPL1530
C     BLANKING OUT MATRIX-(GRID)                                        UTPL1540
C                                                                       UTPL1550
  299 DO 300 I=1,61                                                     UTPL1560
      DO 301 JJ=1,81                                                    UTPL1570
301   GRID(I,JJ)=BLANK                                                  UTPL1580
  300 CONTINUE                                                          UTPL1590
      IF(XMAX*XMIN.GE.0.) GO TO 222                                     UTPL1600
      IYAXIS=80.*(-XMIN)/XRANGE+1.5                                     UTPL1610
      DO 40 I=1,61                                                      UTPL1620
   40 GRID(I,IYAXIS)=DOT                                                UTPL1630
  222 IF(YMAX*YMIN.GE.0.) GO TO 333                                     UTPL1640
      IXAXIS=60.*YMAX/YRANGE+1.5                                        UTPL1650
      DO 60 I=1,81                                                      UTPL1660
   60 GRID(IXAXIS,I)=DOT                                                UTPL1670
C                                                                       UTPL1680
C     COMPUTE PROPER SCALE NUMBERS                                      UTPL1690
C                                                                       UTPL1700
  333 XINCR=XRANGE/4.                                                   UTPL1710
      YINCR=YRANGE/6.                                                   UTPL1720
      XSCALE(1)=XMAX                                                    UTPL1730
      XSCALE(5)=XMIN                                                    UTPL1740
      DO 80 I=2,4                                                       UTPL1750
      XSCALE(I)=XSCALE(I-1)-XINCR                                       UTPL1760
      IF(ABS(XSCALE(I)).LT.1.E-4) XSCALE(I)=0.                          UTPL1770
   80 CONTINUE                                                          UTPL1780
      YSCALE(1)=YMAX                                                    UTPL1790
      YSCALE(7)=YMIN                                                    UTPL1800
      DO 81 I=2,6                                                       UTPL1810
      YSCALE(I)=YSCALE(I-1)-YINCR                                       UTPL1820
      IF(ABS(YSCALE(I)).LT.1.E-4) YSCALE(I)=0.                          UTPL1830
   81 CONTINUE                                                          UTPL1840
      DO 85 II=1,2                                                      UTPL1850
      JJ=6-II                                                           UTPL1860
      XT=XSCALE(JJ)                                                     UTPL1870
      XSCALE(JJ)=XSCALE(II)                                             UTPL1880
   85 XSCALE(II)=XT                                                     UTPL1890
C                                                                       UTPL1900
```

```
C                                                                        UTPL1910
C     PLACING POINTS IN THEIR PROPER GRID POSITIONS                      UTPL1920
C                                                                        UTPL1930
  444 IF(MODCUR.LT.2) JSET=0                                             UTPL1940
      IF(JERR.GT.0) GO TO 885                                            UTPL1950
      JSET=JSET+1                                                        UTPL1960
      IF(JSET.GT.4) JSET=1                                               UTPL1970
      DO 700 I=1,KDATA,KKZ                                               UTPL1980
      IPTX=60.*(YMAX-Y(I))/YRANGE+1.5                                    UTPL1990
      IPTY=80.*(X(I)-XMIN)/XRANGE+1.5                                    UTPL2000
      IF(IPTX.GT.61.OR.IPTY.GT.81) GO TO 70                              UTPL2010
      IF(IPTX.LE.0.OR.IPTY.LE.0)GO TO 70                                 UTPL2020
      GRID(IPTX,IPTY) = XCHAR(JSET)                                      UTPL2030
      GO TO 700                                                          UTPL2040
   70 IERR=IERR+1                                                        UTPL2050
  700 CONTINUE                                                           UTPL2060
C     OUTPUT SECTION WITH GRAPH                                          UTPL2070
C                                                                        UTPL2080
      IF(MODCUR.EQ.1.OR.MODCUR.EQ.2) RETURN                              UTPL2090
      AXR=ABS(XRANGE)                                                    UTPL2100
      AYR=ABS(YRANGE)                                                    UTPL2110
      IF(AXR.LT.1.E+8.AND.AXR.GE..95) GO TO 400                          UTPL2120
      WRITE(6,17) XSCALE                                                 UTPL2130
   17 FORMAT(12X,1PE10.3,4(10X,E10.3)/15X,'**',8('+*********'),'+**')    UTPL2140
      GO TO 401                                                          UTPL2150
  400 WRITE(6,117) XSCALE                                                UTPL2160
  117 FORMAT( 8X,F11.2,4( 9X,F11.2)/15X,'**',8('+*********'),'+**')      UTPL2170
  401 II=1                                                               UTPL2180
      DO 101 IK=1,61                                                     UTPL2190
      IF(MOD(IK-1,10).NE.0) GO TO 92                                     UTPL2200
      IF(AYR.LT.1.E+8.AND.AYR.GE..95) GO TO 404                          UTPL2210
      WRITE(6,18) YSCALE(II),(GRID(IK,IX),IX=1,81),YSCALE(II)            UTPL2220
   18 FORMAT(3X,1PE10.3,2X,1H+,1X,81A1,1X,1H+,2X,E10.3)                  UTPL2230
      GO TO 405                                                          UTPL2240
  404 WRITE(6,118) YSCALE(II),(GRID(IK,IX),IX=1,81),YSCALE(II)           UTPL2250
  118 FORMAT(2X,F11.2,'  + ',81A1,' +  ',F11.2)                          UTPL2260
  405 II=II+1                                                            UTPL2270
      GO TO 101                                                          UTPL2280
   92 WRITE(6,19) (GRID(IK,IX),IX=1,81)                                  UTPL2290
   19 FORMAT(15X,'* ',81A1,' *')                                         UTPL2300
  101 CONTINUE                                                           UTPL2310
      IF(AXR.LT.1.E+8.AND.AXR.GE..95) GO TO 402                          UTPL2320
      WRITE(6,22) XSCALE                                                 UTPL2330
   22 FORMAT(15X,'**',8('+*********'),'+**'/12X,1PE10.3,4(10X,E10.3),//)UTPL2340
      GO TO 403                                                          UTPL2350
  402 WRITE(6,217) XSCALE                                                UTPL2360
  217 FORMAT(15X,'**',8('+*********'),'+**'/ 8X,F11.2,4( 9X,F11.2),//)  UTPL2370
  403 IF(IERR.GT.0) WRITE(6,20) IERR                                     UTPL2380
```

```
   20  FORMAT(10X 'NUMBER OF POINTS OUT OF RANGE ='  I4)                    UTPL2390
 1000  RETURN                                                                UTPL2400
C                                                                            UTPL2410
  889  WRITE(6,888)                                                          UTPL2420
  888  FORMAT(' ALL Y VALUES=0. CANNOT SETUP PLOT GRID. CHECK MAX & MIN YUTPL2430
      1 WHEN MODCUR=0 OR 1.')                                                UTPL2440
       JERR=10                                                               UTPL2450
       RETURN                                                                UTPL2460
  887  WRITE(6,886)                                                          UTPL2470
  886  FORMAT(' ALL X VALUES=0. CANNOT SETUP PLOT GRID. CHECK MAX & MIN XUTPL2480
      1 WHEN MODCUR=0 OR 1.')                                                UTPL2490
       JERR=10                                                               UTPL2500
       RETURN                                                                UTPL2510
  885  WRITE(6,884)                                                          UTPL2520
  884  FORMAT(' GRID NOT SETUP WHEN MODCUR LAST 0 OR 1. NO PLOT UNTIL GRIUTPL2530
      1D PROPERLY SETUP')                                                    UTPL2540
       RETURN                                                                UTPL2550
       END                                                                   UTPL2560
```

APPENDIX E. LAGRANGE COMPUTATIONS

Minimize the budget subject to production function constraints.

$$\text{MINIMIZE } B = P^L(L_1+L_2+L_3) + P^M(M_1+M_2+M_3$$

$$+ M^P(P_1+P_2 +P_3)$$

$$\text{S.T.} \quad Q_1 = a_1L_1^{\alpha_1} M_1^{\beta_1} P_1^{\gamma_1}$$

$$Q_2 = a_2L_2^{\alpha_2} M_2^{\beta_2} P_2^{\gamma_2}$$

$$Q_3 = a_3L_3^{\alpha_3} M_3^{\beta_3} P_3^{\gamma_3}$$

Lagrange Equation:

$$\mathcal{L} = P^L(L_1+L_2+L_3)+P^M(M_1+M_2+M_3)+P^P(P_1+P_2+P_3)$$

$$- \lambda_1(Q_1-a_1L_1^{\alpha_1}M_1^{\beta_1}P_1^{\gamma_1})-\lambda_2(Q_2-a_2L_2^{\alpha_2}M_2^{\beta_2}P_2^{\gamma_2})$$

$$- \lambda_3(Q_3-a_3L_3^{\alpha_3}M_3^{\beta_3}P_3^{\gamma_3})$$

STEP 1 By taking the partial derivative with respect to each of the resources and λ, twelve simultaneous equations can be written.

$$(1)\quad \frac{\partial L}{\partial L_1} = P^L + \lambda_1 a_1 \alpha_1 L_1^{\alpha_1 - 1} M_1^{\beta_1} P_1^{\gamma_1} = 0$$

$$(2)\quad \frac{\partial L}{\partial L_2} = P^L + \lambda_2 a_2 \alpha_2 L_2^{\alpha_2 - 1} M_2^{\beta_2} P_2^{\gamma_2} = 0$$

$$(3)\quad \frac{\partial L}{\partial L_3} = P^L + \lambda_3 a_3 \alpha_3 L_3^{\alpha_3 - 1} M_3^{\beta_3} P_3^{\gamma_3} = 0$$

$$(4)\quad \frac{\partial L}{\partial M_1} = P^M + \lambda_1 a_1 \beta_1 L_1^{\alpha_1} M_1^{\beta_1 - 1} P_1^{\gamma_1} = 0$$

$$(5)\quad \frac{\partial L}{\partial M_2} = P^M + \lambda_2 a_2 \beta_2 L_2^{\alpha_2} M_2^{\beta_2 - 1} P_2^{\gamma_2} = 0$$

$$(6)\quad \frac{\partial L}{\partial M_3} = P^M + \lambda_3 a_3 \beta_3 L_3^{\alpha_3} M_3^{\beta_3 - 1} P_3^{\gamma_3} = 0$$

$$(7)\quad \frac{\partial L}{\partial P_1} = P^P + \lambda_1 a_1 \gamma_1 L_1^{\alpha_1} M_1^{\beta_1} P_1^{\gamma_1 - 1} = 0$$

$$(8)\quad \frac{\partial L}{\partial P_2} = P^P + \lambda_2 a_2 \gamma_2 L_2^{\alpha_2} M_2^{\beta_2} P_2^{\gamma_2 - 1} = 0$$

$$(9)\quad \frac{\partial L}{\partial P_3} = P^P + \lambda_3 a_3 \gamma_3 L_3^{\alpha_3} M_3^{\beta_3} P_3^{\gamma_3 - 1} = 0$$

$$(10)\quad \frac{\partial L}{\partial \lambda_1} = 0 \quad \underset{\Longleftrightarrow}{\text{IFF}} \quad Q_1 = a_1 L_1^{\alpha_1} M_1^{\beta_1} P_1^{\gamma_1}$$

$$(11) \quad \frac{\partial \mathcal{L}}{\partial \lambda_2} = 0 \quad \underset{<=>}{\text{IFF}} \quad Q_2 = a_2 L_2^{\alpha_2} M_2^{\beta_2} P_2^{\gamma_2}$$

$$(12) \quad \frac{\partial \mathcal{L}}{\partial \lambda_3} = 0 \quad \underset{<=>}{\text{IFF}} \quad Q_3 = a_3 L_3^{\alpha_3} M_3^{\beta_3} P_3^{\gamma_3}$$

STEP 2. Put into equations (1) to (9) the values of Q_1, Q_2, Q_3 from equations (10), (11) and (12).

Equations (1) to (9) are rewritten as follows:

$$(1) \quad P^L + \frac{\lambda_1 \alpha_1 Q_1}{L_1} = 0$$

$$(2) \quad P^L + \frac{\lambda_2 \alpha_2 Q_2}{L_2} = 0$$

$$(3) \quad P^L + \frac{\lambda_3 \alpha_3 Q_3}{L_3} = 0$$

$$(4) \quad P^M + \frac{\lambda_1 \beta_1 Q_1}{M_1} = 0$$

$$(5) \quad P^M + \frac{\alpha_2 \beta_2 Q_2}{M_2} = 0$$

$$(6) \quad P^M + \frac{\lambda_3 \beta_3 Q_3}{M_3} = 0$$

$$(7) \quad P^P + \frac{\lambda_1 \gamma_1 Q_1}{P_1} = 0$$

$$(8) \quad P^P + \frac{\lambda_2 \gamma_2 Q_2}{P_2} = 0$$

$$(9) \quad P^P + \frac{\lambda_3 \gamma_3 Q_3}{P_3} = 0$$

STEP 3. The λ's are in this case the shadow prices and are here isolated to look at equal expressions.

$$(1) \quad -\frac{L_1 P_1^L}{\alpha_1 Q_1} = \lambda_1$$

$$(4) \quad -\frac{M_1 P_1^M}{\beta_1 Q_1} = \lambda_1$$

$$(7) \quad -\frac{P_1 P_1^P}{\gamma_1 Q_1} = \lambda_1$$

$$(2) \quad -\frac{L_2 P_2^L}{\alpha_2 Q_2} = \lambda_2$$

$$(5) \quad -\frac{M_2 P_2^M}{\beta_2 Q_2} = \lambda_2$$

$$(8) \quad -\frac{P_2 P_2^P}{\gamma_2 Q_2} = \lambda_2$$

$$(3) \quad -\frac{L_3 P_3^L}{\alpha_3 Q_3} = \lambda_3$$

$$(6) \quad -\frac{M_3 P_3^M}{\beta_3 Q_3} = \lambda_3$$

$$(9) \quad -\frac{P_3 P_3^P}{\gamma_3 Q_3} = \lambda_3$$

STEP 4. Eliminate output variables in order to look at relationships between resources.

(I) (1) and (4) $\quad \dfrac{L_1 P^L}{\alpha_1 Q_1} = \dfrac{M_1 P^M}{\beta_1 Q_1}, \quad \dfrac{P^L}{P^M} = \dfrac{M_1 \alpha_1}{L_1 \beta_1}$

(II) (1) and (7) $\quad \dfrac{L_1 P^L}{\alpha_1 Q_1} = \dfrac{P_1 P^P}{\gamma_1 Q_1}, \quad \dfrac{P^L}{P^P} = \dfrac{P_1 \alpha_1}{L_1 \gamma_1}$

(III) (4) and (7) $\quad \dfrac{M_1 P^M}{\beta_1 Q_1} = \dfrac{P_1 P^P}{\gamma_1 Q_1}, \quad \dfrac{P^M}{P^P} = \dfrac{P_1 \beta_1}{M_1 \gamma_1}$

By following the same method with (2),(3),(5),(6),(8),(9) the following relationships are also true:

(IV) $\quad \dfrac{P^L}{P^M} = \dfrac{M_2 \alpha_2}{L_2 \beta_2}$

(V) $\quad \dfrac{P^L}{P^P} = \dfrac{P_2 \alpha_2}{L_2 \gamma_2}$

(VI) $\quad \dfrac{P^M}{P^P} = \dfrac{P_2 \beta_2}{M_2 \gamma_2}$

(VII) $\quad \dfrac{P^L}{P^M} = \dfrac{M_3 \alpha_3}{L_3 \beta_3}$

(VIII) $\quad \dfrac{P^L}{P^P} = \dfrac{P_3 \alpha_3}{L_3 \gamma_3}$

(IX) $\quad \dfrac{P^M}{P^P} = \dfrac{P_3 \beta_3}{M_3 \gamma_3}$

STEP 5. Substitute resources in the production function to arrive at outputs in terms of a single resource. One example will show the method and the results can be extrapolated to all production functions. Look at the aircraft production function in terms of labor only.

$$Q_1 = aL_1^{\alpha_1} M_1^{\beta_1} P_1^{\gamma_1}$$

M_1 in terms of L_1 from eq. (I)

$$M_1 = \frac{\beta_1 P^L L_1}{\alpha_1 P^M}$$

P_1 in terms of L_1 from eq. (II)

$$P_1 = \frac{\gamma_1 P^L L_1}{\alpha_1 P^P}$$

$$Q_1 = a_1 L_1^{\alpha_1} \left(\frac{\beta_1 P^L L_1}{\alpha_1 P^M}\right)^{\beta_1} \left(\frac{\gamma_1 P^L L_1}{\alpha_1 P^P}\right)^{\gamma_1}$$

$$Q_1 = a_1 \left(\frac{\beta_1 P^L}{\alpha_1 P^M}\right)^{\beta_1} \left(\frac{\gamma_1 P^L}{\alpha_1 P^P}\right)^{\gamma_1} L_1^{(\alpha_1+\beta_1+\gamma_1)}$$

Since $a, \alpha, \beta, \gamma, P^L, P^M, P^P$ are all constants this expression can be rewritten as

$$Q_1 = AL_1^u \quad \text{where } A = a_1 \left(\frac{\beta_1 P^L}{\alpha_1 P^M}\right)^{\beta_1} \left(\frac{\gamma_1 P^L}{\alpha_1 P^P}\right)^{\gamma_1} \quad \text{and}$$

$$u = \alpha_1 + \beta_1 + \gamma_1$$

Q_1 in terms of material will be represented by

$$Q_1 = BM_1^u \qquad \text{where } B = a_1\left(\frac{\beta_1 P^L}{\alpha_1 P^M}\right)^{\alpha_1} \left(\frac{\gamma_1 P^M}{\beta_1 P^P}\right)^{\gamma_1}$$

$$\text{and } u = \alpha_1+\beta_1+\gamma_1$$

Q_1 in terms of pipeline will be:

$$Q_1 = CP_1^u \qquad \text{where } C = a_1\left(\frac{\alpha_1 P^P}{\gamma_1 P^L}\right)^{\alpha_1} \left(\frac{\gamma_1 P^M}{\beta_1 P^P}\right)^{\beta_1}$$

$$\text{and } u = \alpha_1+\beta_1+\gamma_1$$

This method will give output equations in terms of each input. The constants for Q_2 and Q_3 are D,E,F and G,H,J respectively. The values for these constants can be found in the same manner as A,B, and C. Constants for engine output expressions are:

$$D = a_2\left(\frac{\beta_2 P^L}{\alpha_2 P^M}\right)^{\beta_2} \left(\frac{\gamma_2 P^L}{\alpha_2 P^P}\right)^{\gamma_2}$$

$$E = a_2\left(\frac{\beta_2 P^L}{\alpha_2 P^M}\right)^{\alpha_2} \left(\frac{\gamma_2 P^M}{\beta_2 P^P}\right)^{\gamma_2}$$

$$F = a_2\left(\frac{\alpha_2 P^P}{\gamma_2 P^L}\right)^{\alpha_2}\left(\frac{\gamma_2 P^M}{\beta_2 P^P}\right)^{\beta_2}$$

The constants D,E, and F allow the equations for engine output to be written as follows:

$$Q_2 = DL_2^v$$

$$Q_2 = EM_2^v$$

$$Q_2 = FP_2^v \qquad \text{where } v = \alpha_2+\beta_2+\gamma_2$$

constants for component output are:

$$G = a_3\left(\frac{\beta_3 P^L}{\alpha_3 P^M}\right)^{\beta_3}\left(\frac{\gamma_3 P^L}{\alpha_3 P^P}\right)^{\gamma_3}$$

$$H = a_3\left(\frac{\beta_3 P^L}{\alpha_3 P^M}\right)^{\alpha_3}\left(\frac{\gamma_3 P^M}{\beta_3 P^P}\right)^{\gamma_3}$$

$$J = a_3\left(\frac{\alpha_3 P^P}{\gamma_3 P^L}\right)^{\alpha_3}\left(\frac{\gamma_3 P^M}{\beta_3 P^P}\right)^{\beta_3}$$

the component equations become

$$Q_3 = GL_3^w$$

$$Q_3 = HM_3^w$$

$$Q_3 = JP_3^w \qquad \text{where } w = \alpha_3+\beta_3+\gamma_3$$

STEP 6. Using the relationships found in step 5, the budget function is written in terms of output and prices of L, M, and P.

$$\mathcal{B} = P^L(L_1+L_2+L_3)+P^M(M_1+M_2+M_3)+P^P(P_1+P_2+P_3)$$

$$\mathcal{B} = P^L[(\frac{Q_1}{A})^{\frac{1}{u}} + (\frac{Q_2}{D})^{\frac{1}{v}} + (\frac{Q_3}{G})^{\frac{1}{w}}]$$

$$+ P^M[(\frac{Q_1}{B})^{\frac{1}{u}} + (\frac{Q_2}{E})^{\frac{1}{v}} + (\frac{Q_3}{H})^{\frac{1}{w}}]$$

$$+ P^P[(\frac{Q_1}{C})^{\frac{1}{u}} + (\frac{Q_2}{F})^{\frac{1}{v}} + (\frac{Q_3}{J})^{\frac{1}{w}}]$$

or

$$\mathcal{B} = (\frac{P^L}{A^{\frac{1}{u}}} + \frac{P^M}{B^{\frac{1}{u}}} + \frac{P^P}{C^{\frac{1}{u}}})Q_1^{\frac{1}{u}} + (\frac{P^L}{D^{\frac{1}{v}}} + \frac{P^M}{E^{\frac{1}{v}}} + \frac{P^P}{F^{\frac{1}{v}}})\ Q_2^{\frac{1}{v}}$$

$$+ (\frac{P^L}{G^{\frac{1}{w}}} + \frac{P^M}{H^{\frac{1}{w}}} + \frac{P^P}{J^{\frac{1}{w}}})\ Q_3^{\frac{1}{w}} .$$

$$B = K_1 Q_1^{\frac{1}{u}} + K_2 Q_2^{\frac{1}{v}} + K_3 Q_3^{\frac{1}{w}}$$

where K_1, K_2, and K_3 represent values in parentheses from previous equation.

APPENDIX F. CURVE DERIVATION

The budget $= B = K_1 Q_1^{\frac{1}{u}} + K_2 Q_2^{\frac{1}{v}}$

Rewrite the equation:

$$Q_2^{\frac{1}{v}} = \frac{B}{K_2} - \frac{K_1}{K_2} Q_1^{\frac{1}{u}}$$

$$Q_2 = \left(\frac{B}{K_2} - \frac{K_1}{K_2} Q_1^{\frac{1}{u}}\right)^{v}$$

First Derivative:

$$Q_2' = \left[v\left(\frac{B}{K_2} - \frac{K_1}{K_2} Q_1^{\frac{1}{u}}\right)^{v-1}\right]\left[-\frac{K_1}{K_2} \frac{1}{u} Q_1^{\frac{1}{u}-1}\right]$$

Second Derivative:

$$Q_2'' = \left[v\left(\frac{B}{K_2} - \frac{K_1}{K_2} Q^{\frac{1}{u}}\right)^{v-1} \left(-\frac{K_1}{K_2} \frac{1}{u} \frac{1-u}{u} Q_1^{\frac{1}{u}-2}\right)\right]$$

$$+ v(v-1)\left(\frac{B}{K_2} - \frac{K_1}{K_2} Q_1^{\frac{1}{u}}\right)^{v-2} \left(-\frac{K_1}{K_2} \frac{1}{u} Q_1^{\frac{1}{u}-1}\right)\left(-\frac{K_1}{K_2} \frac{1}{u} Q_1^{\frac{1}{u}-1}\right)$$

$$Q_2'' = v \frac{K_1}{K_2} \frac{1}{u} \left(\frac{B}{K_2} - \frac{K_1}{K_2} Q_1^{\frac{1}{u}}\right)^{v-2} \left[\frac{B}{K_2} \frac{u-1}{u} Q_1^{\frac{1}{u}-2}\right.$$

$$\left. + \left(\frac{K_1}{K_2} \frac{1-u}{u} + (v-1) \frac{K_1}{K_2} \frac{1}{u} Q_1^{\frac{2}{u}-2}\right)\right]$$

$$Q_2'' = v \frac{K_1}{K_2} \frac{1}{u} \left(\frac{B}{K_2} - \frac{K_1}{K_2} Q_1^{\frac{1}{u}}\right)^{v-2} \frac{1}{K_2} \frac{1}{u} [B(u-1)Q_1^{\frac{1}{u}-2}$$

$$+ (K_1(1-u) + K_1(v-1))Q_1^{\frac{2}{u}-2}]$$

$$Q_2'' = vK_1 \frac{1}{K_2^3} \frac{1}{u^2} (a_3-K_1Q_1^{\frac{1}{u}})^{v-2} Q_1^{\frac{1}{u}-2} \{B(u-1)$$

$$+ [K_1(1-u) + K_1(v-1)]Q_1^{\frac{1}{u}}\}$$

$$Q_2'' = \frac{K_1}{K_2^3} \frac{v}{u^2} (B-K_1Q_1^{\frac{1}{u}})^{v-2} Q_1^{\frac{1}{u}-2} [B(u-1)+K_1(v-u)Q_1^{\frac{1}{u}}]$$

>0

>0 >0 sign dependent on u and v

Replace B with $K_1Q_1^{\frac{1}{u}}+K_2Q_2^{\frac{1}{v}}$ in bracketed part of Q_2''.

$$[B(u-1) + K_1(v-u)Q_1^{\frac{1}{u}}] = [(K_1Q_1^{\frac{1}{u}}+K_2Q_2^{\frac{1}{v}})(u-1)+K_1(v-u)Q_1^{\frac{1}{u}}]$$

$$= [(K_1Q_1^{\frac{1}{u}}((u-1)+(v-u))+K_2Q_2^{\frac{1}{v}}(u-1)]$$

$$= \underline{K_1Q_1^{\frac{1}{u}}(v-1) + K_2Q_2^{\frac{1}{v}}(u-1)}$$

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13. ABSTRACT

The Management System Development Office (MSDO) of the Naval Air Integrated Logistic Support Center (NAILSC) is presently evaluating a prototype system at the Naval Air Rework Facility, North Island (NARFNI). The system is called "work-in-progress inventory control system", (WIPICS). This paper is concerned with that evaluation and shall utilize before WIPICS production data provided by NARFNI for analysis. Three production functions for three different outputs each with three input variables are discussed and inter-relationships are identified and explained. Three Cobb-Douglas productions functions constrain the cost minimization problem. Prices of inputs are constant and a minimum budget is derived for various output levels. Finally, a discussion of the possible results and their meanings is offered to improve understanding of the before and after WIPICS analysis.

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